ANOVA IN THE EDUCATIONAL PROCESS

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Analiza dispersiei, ANOVA, reprezintă una din metodele statistice, dintre cele mai puternice în ceea ce priveşte datele de observaţie. În următorul studiu de caz, ca şi element de noutate referitor la studiile ANOVA, se analizează omogenitatea grupelor de lucru, formate din studenţi, în ceea ce priveşte materiile de studiu diferite (este analizat aici procesul de învăţământ din punctul de vedere al cadrelor didactice sau din punctul de vedere al diferitelor materii de studiu şi totodată sunt analizate diferenţele care apar la diferitele materii: materii cu conţinut legat mai mult de inginerie- inginerie electrică, şi materii economice).

Analysis Of Variance, ANOVA, represents one of the statistical procedure proceedings, the most powerful procedure for the observation dates. In the following case study, like an element of improving concerning the ANOVA studies, it is analyzed the homogeneity of the working groups of students referring at different disciplines (it is analyzed here the teaching process from teaching's or discipline's point of view and the differences who comes up at different disciplines like: electrical and economics).

Keywords: ANOVA, homogeneity, teaching process, normal distribution, Fisher test, educational process.

1. Introduction

Analysis of Variance, ANOVA, was put in practice by the mathematician Fisher. Pointedly the problem solved by Fisher was: the mean of a population to another mean of population, meaning testing the homogeneity of the means. The economic component of such an experimental procedures is that, it allows to identify the significant effects with a minimal experimental effort, meaning a low number of measurements. The methods established by Fisher and the generalizations are known as „planning" or „experiments programming" or shorter ANOVA. [1], [2]

Generally it is considered that the experiment is a research method, in which the researcher has the power to change one or more explicative variables (independent), and that, after the change is made, you can measure its effect on the resultant variables (flows). [3]

In another definition, ANOVA is an assembly of methods for the examination of the study dates, dates which depend on several factors with

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simultaneous action, in purpose of establishing the most important of them and to estimate their effects. [4]

After the calculation in Mathematics, the ANOVA table will show, in the displayed result by Mathematics, the squares sum, which is split in four or five components. For each component, the table shows: the squares sum, degree freedom, the square media and ratio F. Each ratio F is the ratio of the square media's value for that variance source of the residual square media. If the null hypothesis is true, the ratio F is proximate 1. If it is not true, F is higher than 1. [5], [6]

2. Case study, the analysis of variance

The specific analyzed example concerns about the students from the Electrical Engineering Faculty, on three different working groups.

The first group of students, group A *Table 1*

Number of students	Grades at X subject	Grades at Y subject
1	8	6
2	9	10
3	10	9
4	5	6
5	6	9
6	5	5
7	7	8
8	6	8
9	6	8
10	9	10
11	5	8
12	10	9
13	5	6
14	5	6
15	7	10
16	5	6
17	5	6
18	5	6
19	10	10
20	7	10
21	9	10
22	6	10
23	8	10
24	6	6
25	5	9
26	7	9
27	6	6
28	9	9

Table 2

The second group of students, group B

Number of students	Grades at X subject	Grades at Y subject
1	5	5
2	5	5
3	9	9
4	5	5
5	9	10
6	9	7
7	6	9
8	5	5
9	5	5
10	5	5
11	5	5
12	8	9
13	6	7
14	5	5
15	6	6
16	5	5

Table 3

The third group of students, group C

Number of students	Grades at X subject	Grades at Y subject
1	5	5
2	5	7
3	8	10
4	5	5
5	6	6
6	7	6
7	5	5
8	5	5
9	8	6
10	5	6
11	7	9
12	7	6
13	7	6
14	6	7
15	5	5
16	5	6
17	5	6
18	7	6

The case study follows the results from these three different groups of students (we will speak about these groups like A group, B group, C group), from the two disciplines (we will speak about these two subjects like X subject and Y subject).

In the tables seen above, we have the grades from those 3 groups of students, at the X subject and Y subject. The maximum is 10, meaning “the best possible” and the lowest is 1. So, the scale is 1 to 10.

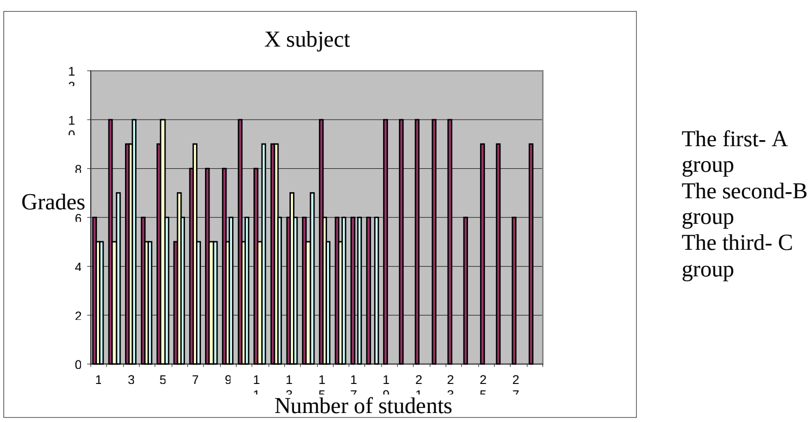

Fig. 1. The grades for the students at X subject

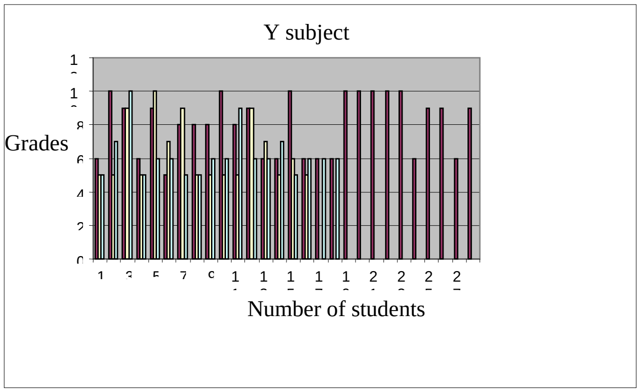

Fig. 2. The grades for the students at Y subject

There are used the methods of the analysis of variance, and we withhold like an influence factor: the deployment of the teaching process. For this we will use like a work technique, the ANOVA analysis.

Anova can be two-ways Anova and one-way Anova. Two-ways Anova answers simultaneous at three questions: The first factor affects the results? The second factors affect the results? Those two factors interconnect?

One-way Anova, in our case, wants to show if the mean results of this two subjects are the same for those three groups of students. We will study the main effects, observed between the columns means.

Anova will test if the possible main effects are statistically significant- that the errors are not only from the sample's error.

Table 4

ANOVA table

Groups of students	The samples		Rows mean
	X subject	Y subject	
A group			
B group			
C group			
Columns mean			

The experiments which depend on one factor only, are the simplest scheme of projection. The objective of this type of experiment is the measurement of the effect of the one or more levels of the experimental factor on two or more experimental groups.

If we analyze a certain process and we check the influence of a certain factor, we can then say that the factor is "a controlled factor". The experiment's diagram may have one or more controlled factors. The rest of factors are called “uncontrolled factors”. This ones determine a normal variation of the investigate characteristic.

For reaching the target (testing the homogeneity), it is need to take into consideration the most important factors, from the point of view of their contribution to the new engineer’s shaping.

The simplest case is the one in which the variation of the characteristic is dependent on a single factor, A. Based on the experiments, we have for k variants, n variants specific to the X characteristic. So, we have the following table:

Table 5

The experimental values

A	a_1	a_2	…..	a_i	…..	a_k
X	x_{11}	x_{21}	…..	x_{i1}	…..	x_{k1}
X	x_{12}	x_{22}	…..	x_{i2}	…..	x_{k2}
X	…..	……	…..	…..	…..	…..
X	…..	……	…..	…..	…..	…..
X	x_{1n}	x_{2n}	…..	x_{in}	…..	x_{kn}

It can be observed that the variation of the results represents a consequence of the all factors without the controlled factor, including the measurement errors.

The statistic study of the plan of the experiments values, shows:

- Hypothesis 1: all the k results have a normal distribution, independent;
- Hypothesis 2: the normal distributions have the same parameter.

If the normality doesn’t exist then, we will compare the mean values, using the F test. The hypothesis 2 means that the controlled factor influences the mean, not the variance.

3. The implementation in Mathematics

For this case study, the dates are implemented in Mathematics 5.2, which is a soft used for calculation, including reliability case studies. The first step for analysis is to test if the two samples of dates have a normal distribution, using the Kolmogorov-Smirnov test. [4]

Than it will be test the normality using mathematics and it will be calculate the maximum difference between the theoretical and empirical functions:

$D_{nA} = 0.276582$, respective: $D_{nB} = 0.259126$.

The problem is to test the equality between the variances for those two samples. For this are analyzed the results from calculation and from the tables (on one hand it is calculate an indicator: $F_c = \frac{s_A^2}{s_B^2}$ and on the other hand, for a certain significance level, it is extracted a value from the Fisher table). [7], [8], [9]

From the Fisher table it is extracted the value $F_\alpha(1,141) = 2.74$ for $\alpha = 0.1$, and ν_A , ν_B are the numbers of the freedom degrees. But $F_c = \frac{s_A^2}{s_B^2}$=2.15 so, 2.15 < 2.74, this means that the means of the two samples aren't significant different, and the influence of the controlled factor (professors in this case) isn't significant.

The ANOVA table splits the total variability between measurements (showed like a sum of squares) in four components:

- interaction between rows and columns;
- variability lengthways of columns;
- variability leng
- thways of rows;
- residual error.

With many measurements, Anova has another component:

- variability between subjects.

The ANOVA table shows the squares sum which is split in four components (or five components). For each component, the table shows: sum of squares, degree freedom, mean square and ratio F. Each ratio is the ratio of the value of the mean square for that source of variation of the residual mean square. If the null hypothesis is true, the ratio F is almost 1. If it is not true, F is higher than 1.

4. Conclusions

Using the Anova steps, in this case study few elements are analyzed. First of all it is tested if the two samples have a normal distribution. For this it is calculate the means, the variances, the theoretical functions of repartition, and the values of the theoretical functions of repartition, the values of the empirical functions of repartition, the calculation of the difference modules, the maximum of the difference between the theoretical and empirical functions. For a trust level of 5% for those two samples, the values from the Kolmogorov - Smirnov table are lower that the calculate values. So, this means that none of the two distributions are normal.

The next step is Fisher test which tests the hypothesis concerning the equality of the means of the two samples.

This test reveals that the calculated value ($F_c = \frac{s_A^2}{s_B^2} = 2.15$) is lower that the value from the Fisher table ($\frac{D_A}{D_R} < F_\alpha, F_\alpha(1{,}141) = 2.74$). So, that means that the means of those two samples aren't significant different, this also means that the influence of the controlled factor (in our case, the professors) it is not significant.

Those two samples represent:

A = the grades for X subject, for those three working groups;

B= the grades for Y subject, for those three working groups.

Total amount for each sample is 62 dates.

The means for the two samples are: for A is 6.40 and for B is 7.08. So the means are significant different and this means that those two working groups are homogene from the point of view of the didactical process. The homogeneity is the same although we have different subjects like content (electrical and economic), also different teachers with different didactical methods, and different specializations.

So it is tested one way ANOVA, especially we tested the mean results at two subjects of study, on three working groups of students.

The independent variables were those two subjects of study and the dependent variables were the grades measured on a scale from 1 to 10.

After the factors took into consideration, the experiments can be:

- with one factor (simple);
- with multiple factors, where we study not only the action of each factor but also the dependence between them.

From this point of view, the analysed case study reffers to a one way experiment (simple experiment).

After the variables type, so after factors, the experiments can be:

- experiments concerning the quantitative factors, who can be easy measured (like temperature, time, speed, and so on);
- experiments made on attributive factors (profession, area, and so on).

From this point of view, the experiment involved in this case study concerns the quantitative factors, easy to measure: grades.

After the purpose, the experiments can be:

- preliminary experiments, where we want to test a lots of factors for an idea concerning the future researches;
- critical experiments, where it is compared the results of different treatments, for an identification and a test for the ones with a significant influence;

- demonstrative experiments, where it can be tested few treatments with a determined standard.

From this point of view, the case study deals with a critical experiment. Are compared the results of the different didactical methods applied on different working groups, to be able to identify (where are significant differences) and test the ones significant like influence. [10], [11]

The personal contribution of the author on this paper is, on one hand, a complex study on the statistical method Anova and on the other hand, a case study concerning the student groups homegeneity taking into consideration different disciplines. This case study is a new domain which hasn't been approached very often until now.

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