ROMAI J., **3**, 1(2007), 189–197

THE χ^2 HOMOGENEITY TEST APPLIED TO DETERMINE THE EFFICIENCY OF MULTIMEDIA TECHNOLOGY IN THE TEACHING-LEARNING PROCESS

Luminiţa Şerbănescu

University of Piteşti

luminitaserb@yahoo.com

Abstract The experimental implementation and the determination of the efficiency of multimedia teaching-learning technologies was done with the purpose of establishing the necessity of transformations that are paramount for the educational system, in order to synchronize it with the general development tendencies of contemporary society. This article highlights some ways in which various statistical methods are applied in view of comparing modern teaching methods, based on implementing informational technologies, with traditional ones tested, for a period of two years, in parallel groups: experimental and control groups.

The immediacy of the investigation topic consists in the fact that, last few years, society has forwarded ever more persistent demands regarding everything related to computers: training specialists in applying computer systems by developing abilities in finding, gathering and comprehending information, in applying information and communication technology in its processing, in constructing virtual models of objects and actions from the real world. Advanced information technology has contributed to the increase of motivation in studying certain subject matters, that have nothing in common with informatics, because these facilitate learning, due to the fact that individual characteristics, abilities and preferences of the student are taking into consideration, thus

ensuring "the existence of reverse connections (feedback) between the student and the program [2], increasing the efficiency of the learning process."

Consequently, information technology is more and more frequently used in various spheres of human activity: medicine, finance, mass media, science, including education.

By bringing forward these arguments we can state that the reinvigoration of the educational process is basically impossible, without implementing advanced information technology, including multimedia technology. Within the scientific experiments, we propose various alternatives for organizing experimental groups. Organizing the experiments will be performed according to the following methods: the single group technique, the parallel or equivalent groups technique, the factor variation technique.

In the research experiment, we have applied the technique of parallel groups which requires the involvement of four groups of second year students, majoring in Finance and Banking.

In the measuring activity, the objects or their characteristics are assigned numbers, i.e. arbitrary amounts, with the condition that the established measurement rules ensure the viability of the admitted measuring function [1]. Measuring is an indispensable condition for later processing and interpretation of research results. In order for the measurement to observe the validation conditions it is compulsory to determine the characteristics of the phenomena, which we intend to measure and to use the most proper measuring tool. In educational research we can distinguish several steps of the evaluation:

1 the first step is the recording, which consists of detecting the presence or lack of an objective behavioral traits. Within this stage, the subjects and their answers will be counted, grades and averages of the same size will be counted etc.;

2 the second step of quantitative evaluation is ranking or classifying. It consists of outlining the research objects in a ascending or descending succession. Ranking the parameters based on certain traits which are common to all of them is called the procedure of the rank. Ranking the elements of the string is done based on a determined criterion. The position of each case in the string represents its rank within the group, which is attributed a number. If the evaluation of the exam performances is reported to the score of a test, the number of points obtained by each student indicates the rank. "The number obtained with the aid of ranks can serve as guidelines for evaluating the degree in which various categories of skills, behaviors and knowledge have been acquired." [4]

The data indicating the score obtained by each student of the two groups compared and based on the test: for experimental groups and the results of the control group are outlined in Table 1.

Experimental group			Control Group		
Student code	Score for the questions of the test	Grade	Student code	Score for the questions of the test	Grade
IE1	24	8.00	IC1	19	6.33
IE2	22	7.33	IC2	18	6.00
IE3	29	9.67	IC3	25	8.33
IE4	30	10.00	IC4	28	9.33
IE5	15	5.00	IC5	15	5.00
IE6	26	8.67	IC6	24	8.00
IE7	18	6.00	IC7	18	6.00
IE8	23	7.67	IC8	22	7.33

IE9	27	9.00	IC9	21	7.00
IE10	19	6.33	IC10	14	4.67
IIE1	25	8.33	IIC1	20	6.67
IIE2	29	9.67	IIC2	17	5.67
IIE3	28	9.33	IIC3	26	8.67
IIE4	30	10.00	IIC4	21	7.00
IIE5	17	5.67	IIC5	16	5.33
IIE6	26	8.67	IIC6	23	7.67
IIE7	18	6.00	IIC7	18	6.00
IIE8	26	8.67	IIC8	20	6.67
IIE9	30	10.00	IIC9	22	7.33
IIE10	21	7.00	IIC10	13	4.33
IIE11	24	8.00	**Sum/Avg**	**400**	**6.67**
IIE12	30	10.00			
Sum/Avg	**537**	**8.14**			

Table 1. Scores and grades obtained by the students of the two groups.

The χ^2 test is applied when:

- we want to test if it exists the differences between the distributions for a control group and an experimental group. It is a classic research situation where two groups are implied. The data from each group are considered separate patterns [5];
- we want to test if the preferences for a particular subject is different from a zone to other.

In the homogeneity χ^2 test we have a pattern for each group which we want to compare (two groups at least). In our case we considered the experimental group with 22 students and the control group with 20 students.

In the following we present the contingency table.

	Experimental group	**Control group**	
Grades Interval	Observably frequencies (Fo)	Observably frequencies (Fo)	**Total**
4...6	4	8	**12**
6.1...8	6	9	**15**
8.1...10	12	3	**15**
Total	**22**	**20**	**42**

Table 2.Frequency grade for experimental group and control group.

In the case of the homogeneity χ^2 test the totals of the groups are fixed (they represent the measure of the patterns which are established before the beginning of the research). Only the marginal totals of the interest qualitative variable depend on the observably frequencies from cells.

The expected frequencies for the homogeneity χ^2 test are obtained from the formula

$$Fa = \frac{Tr * Tc}{n} \tag{1}$$

where:

- Tr represents the total of the rows;
- Tc represents the total on the columns;
- n is the measure of the patterns.

Using this formula (unique for a contingency table) we compute the expected frequencies:

Grades Interval	**Experimental group**	**Control Group**	**Total**
4...6	4	8	**12**
Fa	6.285	5.714	
6.1...8	6	9	**15**
Fa	7.857	7.142	
8.1...	12	3	**15**
Fa	7.857	7.142	
Total	**22**	**20**	**42**

Table 3. The observation frequencies and the waiting frequencies for the grades from the two groups

The degrees of freedom for the homogeneity test χ^2 are computed from the formula $g.l. = (R-1)(C-1)$ where: R is number of the rows and C is number of the columns. In order to construct this test we follow the following steps:

1 the specification of the null and alternative hypothesis.

H_0**:** the two groups have the same homogenous distributions. This means that the changes of the increases of the notes have a occasional character,

H_1**:** the two groups have not homogenous distributions. This means that the increases of the notes as the result of the application of the multimedia courses in the teaching-learning process have a possible character;

2 the computing the degrees of freedom. Our contingency table has three rows and two columns, therefore $g.l = 2 * l = 2$;

3 the determination of the significance level and the computing of the critical value of the χ^2. We take a generic significance level $\alpha = 0.05$. Because the homogeneity test χ^2 is made only on the right part, the critical value for which the surface from the right part is equal to 5 percentage at two degrees of freedom, is $\chi^2_{critic} = 5.99$;

4 the drawing of the distribution χ^2 and of the repugnant zone. First of all, from fig. 1, we see that the curve has a less usually form. Generally, the curve χ^2 is a oblong curve at right, but in our figure this curve is not the same. This is due to the small number of the degrees of freedom. For two degrees of freedom only, the top of the curve is on the Oy axes;

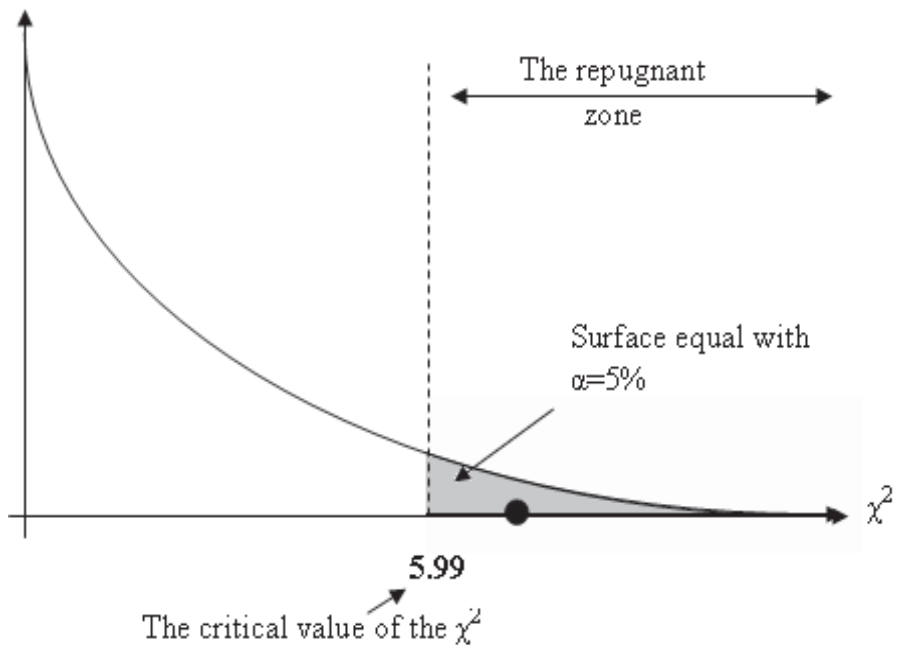

Fig.1. χ^2 curve.

5 the determination of the χ^2 by formula $\chi^2 = \sum_{i=1}^{k} \frac{(Fo-Fa)^2}{Fa}$ where:

- Fo represents observation frequencies,

- Fa represents the waiting frequencies,
- $k = R * C$, in our case $k = 2 * 3 = 6$.

$Fo - Fa$	$(Fo - Fa)^2$	$(Fo - Fa)^2/Fa$
-2.285	5.224489796	0.831169
-1.857	3.448979592	0.438961
4.142	17.16326531	2.184416
2.285	5.224489796	0.914286
1.857	3.448979592	0.482857
-4.142	17.16326531	2.402857

Table 4. The computing of the value χ^2.

After summing we obtain $\chi^2 = 7.2545$ (the point from fig. 1);

6 taking of the decision. Because the calculated χ^2 is larger than critical χ^2, it is in the repulsive zone, therefore we repulse the null hypothesis [3] about the homogeneity of the two groups. In conclusion, the H_1 hypothesis is verified, so, the growing of the notes in the result of the application of the multimedia courses in teaching-learning process has a possible character.

Conclusions

Applying the statistical methods to process experimental data has confirmed hypotheses about the positive impact (influence) of implementing multimedia

courses in the teaching-learning in experimental groups, compared to the traditional method, applied in control groups.

This conclusion is made for the significance level $\alpha = 0,05$. Taking into consideration the fact that the elements of statistical populations are non-homogenous, the conclusion is considered statistical only for elements involved in the experiment. For other experimental elements, this statement is accepted by analogy.

The research in question has tried to propose a new perspective for performing the learning-teaching process, corresponding to present requirements, which, by using information technology, offers new possibilities to stimulate interest, new ways for active involvement of the student in the knowledge process.

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