# Some statistical studies about tutoring and Moodle activities

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ABSTRACT: In this paper we analyze if the tutoring attendance and Moodle tests proposed to students in a first science university course influence the final grade. The goal is to improve the math learning. To this end, we performed some inferential statistical analyzes on these items. The inferential analysis allows us to make predictions to reorient our teaching methodology.

KEYWORDS: Teaching innovation, Moodle, Mathematics e-learning, tutoring.

## 1. INTRODUCTION

One of the topics of the The European Higher Education Area (EHEA) *(1)* is student-centered learning (SCL) *(2, 3, 4)*. This learning approach focuses on skills and practices that allow students to learn throughout their lives and solve problems independently, rather than focusing on the teacher's input *(5)*. Learning Management Systems such as Moodle facilitate the creation of activities so students can acquire the above skills *(6, 7, 8)*.

This paper is a continuation of previous studies *(9-14)*. They analyze some experiments on learning in Mathematics carried out with first-year students of the Chemistry Degree of the University of Cádiz. These studies can be useful because they are easily be extrapolated to every technical degree. In these six papers, it is inquired into if the Moodle tools improve the teaching of Mathematics.

The current paper continues in the same line of work, and analyzes the results achieved by Chemistry students when they perform several activities in a virtual Moodle course. This year, we have used the difference between the scores of the ordinary call (February) and the extraordinary call (June or September) to measure the improvement produced by Moodle activities. In addition, we have studied the possible influence of tutoring sessions on the final grade. We employ statistical inference in these analyzes. The advantage of statistical inference is that the conclusions are not limited to the sample, but rather they allow predictions to be made for future learners.

The study reveals that the Moodle activities performed along the course are reflected in the final exam mark. Of special interest is the progress attained by the students who completed Moodle questionnaires between the ordinary and extraordinary call. Unfortunately, the tutoring sessions does not have such a positive influence on the final exam grade.

Before starting we would like to point out that the following analyzes have been done with the software R and R-Commander.

## 2. STATISTICAL METHODOLOGY

When we apply a descriptive statistical analysis, the conclusions obtained refer only to the observed individuals. In fact, we do not assume that the data are extracted from a larger population. However statistical inference makes propositions about the entire population using only the data extracted from an observable sample *(15)*.

Since the first-year Chemistry students conditions will likely remain unchanged over the next three to four years, we are going to consider a population formed by present and future undergraduates. It is as if we take the students of the courses 2018-2019, 2019-2020,... and bring them to the present next to those of 2017-2018. The undergraduates of the course 2017-2018 then form a sample which can give us information about the entire population. In this way, we can make predictions about the future students which allow us to redirect our teaching methodology.

## 3. THE SAMPLE AND THE ACTIVITIES

The number of students enrolled during the academic year 2017-2018 was 64. Of these, 10 did not appear in any official call. Then our sample consists of 54 students.

The items that we will consider in our analysis are the following:

### 3.1. Tutoring attendance

Several tutorial sessions were proposed to the students. They could used this hour to make questions and resolve doubts about the subject. Moreover, they could choose between individual and couple tutorials, and the session schedule with the tool Scheduler of Moodle.

A high participation in this activity was achieved. Of the 54 students in the sample, 41 attended tutoring at least once, that is, 76% of the sample.

### 3.2. Training tests

During the academic year 2017-2018, 5 compulsory and 30 optional Moodle tests were proposed to the students. The main Moodle tool we have used is the questionnaire, and among its different possibilities we have taken the multiple-choice questions, numerical questions and embedded answers (cloze). We have also utilized Moodle lessons.

To get a wider participation, we made that 12% of the final grade corresponded to these tests. However, the student involvement in training tests was low:

- 66.7% of undergraduates answered 10 or less tests,
- 24.1% answered between 11 and 20 tests, and
- only 9.3% responded more than 20 tests.

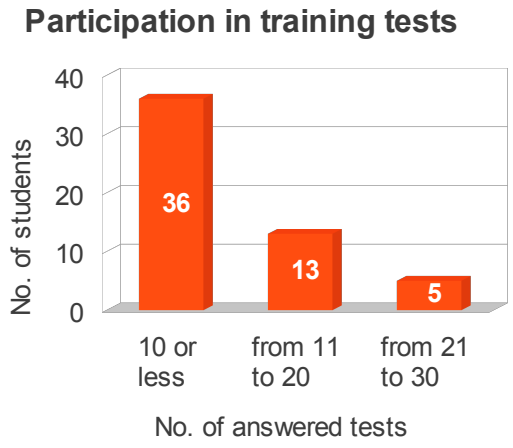


**Figure 1.** Participation in training tests.

On the other hand, the average mark of the 5 compulsory training tests is 0.29 out of 0.8, and only 16.7% of students got at least 0.4 points in these tests.

### 3.3. Final exams marks

We consider the scores of two final exams. The exam of the ordinary call (which took place in February) and the exam of the extraordinary call (June or September).

84% of the enrolled students took part in someone of the final exams. The results are shown in the following table.

| | Ordinary call | Extraordinary call | Total results (best marks) |
|---|---|---|---|
| No. of students | 51 | 36 | 54 |
| Average mark | 1.7 | 3.4 | 3.3 |
| Approved students | 4 | 16 | 20 |

**Table 1.** Results of final exams.

## 4. ANALYSIS OF THE TUTORING ATTENDANCE

In this section, we divided the sample into two groups: students who attended regularly to tutoring sessions (sample 1) and students who did not (sample 0). We wonder if the first group of student obtained a better score at some final exam than the second one.

In order to find out some relevant statistical evidence, we consider two variables: Tutoring and Score. The variable Tutoring is binary and it represents if a student used at least one hour of tutoring (1) or not (0). The variable Score is the maximum score obtained among the three final exams proposed during the course. This second variable has values between 0 and 10.

We would like to test the following hypothesis

H1:= “the average score of students who receive tutoring is larger than those student who not”.

The reverse hypothesis is considered as null hypothesis, denoted by H0.

Since a two independent population test is proposed, we need to check the conditions which are required, i.e., randomness and normality of both samples.

### 4.1. Randomness of the samples

We apply the sign test (whose null hypothesis is ”there exists randomness in the sample”) to both samples, obtaining a p-value = 0.9246 and p-value = 0.2663 for the sample 0 and 1, respectively. These p-values are larger than 0.05 and therefore there is not any statistical evidence to reject the null hypothesis.

### 4.2. Normality of the samples

Next, we use the Shapiro-Wilk test to check the normality of both samples. We recall here that the null hypothesis for Shapiro-Wilk test is to accept the normality of the sample. After applying this test to both samples, we obtain p-value = 0.01959 and p-value = 0.05889, respectively. In this

occasion, we should reject normality for sample 0. Hence, we are not able to do a parametric test.

### 4. 3. Non-parametric test to check the medians

As alternative to average test we propose here to do a non-parametric test to check if the median of one population can be considered greater than the other one. For this purpose we will use the Wilcoxon test for independent samples. In this case, we consider as alternative hypothesis

H1:= "*the median of the score for those students who receive tutoring is greater than the median of those student who not*".

As a result, we obtain a p-value = 0.4315 and then we cannot reject the null hypothesis. This means that the tutoring assistance is not relevant to increase the score of a student.

## 5. STUDENTS WHO DID TESTS VERSUS STUDENTS WHO DID NOT

Now, we propose to analyse if the training tests done, during the period February - September, were useful to increase the students' score in the extraordinary call with respect to the score obtained in the ordinary call of February.

The dataset considered now have 50 individuals (64 students taken the course and we have removed 4 students who passed the exam in February call and 10 students who did not take any exam) and 3 variables: Exam_Ord, Exam_Ext and Training_Test. The two first variables represent the score obtained in the respective exams. The last variable is binary and it tells us about if the students' score obtained in the training tests was satisfactory (1) or not (0).

To carry out the analysis, we need to define a new variable called "Increase" obtained as the difference between Exam_Ord and Exam_Ext.

### 5.1. Randomness

We check if the variable Increase is random for the sample 0 (all individuals who get 0 in the variable Training_Test) and for the sample 1 (otherwise). We apply again the sign test for that purpose, obtaining a p-value = 0.8447 and p-value = 0.2573. Therefore, we can consider that both samples are random.

### 5.2. Normality

After applying the Shapiro-Wilk test to both samples, we get a p-value = 0.1047 and 0.9319. Hence, we do not have evidence to reject the normality in both samples. We are able to do a parametric test for two populations.

### 5.3. Checking the equality of variances

Next, we need to check if both populations can be considered homoscedastics, i.e., both have the same variance. We propose now a Fisher test to check the equality of variance. The corresponding p-value is 0.9532, then we can consider that both populations are homoscedastics.

### 5.4. Parametric test

We consider as alternative hypothesis

H1:= "*The population which has worked satisfactory with the training test obtain larger scores in September than those who do not*".

We proceed to check this hypothesis H1 by using the parametric test for the means of both populations. We obtain a p-value = 0.001678. We have statistical evidences to reject the null hypothesis. Therefore, we can say that the training test have been a useful tool for the student.

## 6. IMPROVEMENT IN FINAL GRADES

Finally, we consider only the students who participated actively in the training tests, and we studied how much their scores have improved. As in the previous analysis, we will consider the scores obtained in the ordinary and extraordinary call.

In this case, we need to select from the dataset of Analysis 2, only the individuals who have worked the training test. Hence, we have a new data set with 21 individuals and 2 variables: Exam_Ord and Exam_Ext. In order to estimate a value for the difference between both average scores, we will make a confidence interval with a 95% of confidence. But before we need to check the randomness and normality of both samples Exam_Ord and Exam_Ext.

### 6.1. Randomness

After applying the sign test for both samples, we get a p-value = 0.8308 and p-value = 0.896, therefore we can consider that both samples are random.

### 6.2. Normality

On the other hand, we apply the Shapiro-Wilk test for both samples, obtaining p-value = 0,156 and p-value = 0.261 for the sample associated to Exam_Ord and Exam_Ext, respectively. We cannot reject the normality for both samples.

### 6.3. Confidence interval for the difference of means

Now, we are able to make a confidence interval for the difference between both means

Exam_Ext – Exam_Ord,

obtaining the following interval:

$IC_{0.95}$[Mean_Ext–Mean_Ord]=[1.7082; 3.4155].

Taking into account that the difference of means can be in that interval with a 95% of confidence, we would say that the average score in September has improved at least 1.7 points. We think that part of this enhance can be explained by the training tests. Therefore, we consider that they are a useful tool for the student.

## 7. DISCUSSION AND CONCLUSIONS

Unlike previous courses, participation in activities has not been high. However the inferential analysis shows that the training tests carried out throughout the course are representative for the final grade of students who have actively participated in them.

This shows that the work made introducing feedback in training tests has paid off, even though the questionnaires are still not attractive for the students.

Unfortunately, the tutoring work is not reflected in the final grade. This makes us think that perhaps we should focus our efforts towards virtual tools such as Moodle questionnaires,...

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