EFFECT OF INTERACTIVE TEACHING AND LEARNING APPROACH ON UNDERGRADUATE STUDENTS’ PERFORMANCE IN PHYSICS

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Abstract

• The study aims to investigate the relatively unknown effect of introducing new technologies of interactive learning on educational performance in terms of learning/assessing physics in higher education. It was conducted over three academic years (2011-2012, 2012-2013, 2013-2014). The study focused on a sample of 1678 students enrolled in the first year of bachelor studies. They studied the fundamental subject Physics 1 in the first semester and the more advanced subject Physics 2 in the second semester. The sample corresponding to each subject was randomly divided in half, representing the experimental and the control groups respectively. After the introduction of the "teaching/evaluation strategy" as independent variable (interactive versus traditional), the ANCOVA method helped us to quantify and compare the standard performances obtained by students in terms of learning Physics 1 and 2. Reporting the data obtained from the results of the initial assessment provided by the standardized admission mean grade revealed the impact of the interactive strategy on the correct identification of students' school performance, as well as offering conclusions on the need for expanding and improving valorization of this type of strategy in the teaching/learning/assessment of physics in higher education. In conclusion, students' academic performance can be measured more accurately by interactive teaching/assessment.
Research Methodology

• Objectives

• O1. The identification/quantification of the initial level of training for physics students at the beginning of the first year of study.

• O2. Setting (by random sampling) of the two groups of students (experimental and control).

• O3. Carrying out the teaching/learning/evaluation process in physics for the experimental group by introducing the "interactive strategies" independent variable (which integrates and emphasize the new technologies in learning);

• O4. Carrying out the teaching/learning/evaluation process in physics for the control group by introducing the "traditional strategies" independent variable.

• O5. The identification/quantification of statistical data in order to evaluate the difference between the two types of learning.

• O6. Comparative analysis of data and their significance.

Study sample: 1678 students specializing in engineering at “Vasile Alecsandri” University of Bacau, Romania, enrolled in 2011-2012, 2012-2013, and 2013-2014
Fig. 2. Results obtained by students in the initial assessment of Physics 1 and 2 courses over three academic years.

Fig. 3. Results obtained by students in the final assessment of Physics 1 and 2 over three academic years.
<table>
<thead>
<tr>
<th>Subject / Academic year</th>
<th>If there are statistically significant differences induced by the teaching strategy</th>
<th>Size of the effect induced by the teaching strategy on the results for learning physics and quantified by the difference between the mean and the grade in physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 1 / 2011-2012</td>
<td>NO</td>
<td>No effect</td>
</tr>
<tr>
<td>Physics 2 / 2011-2012</td>
<td>totally NO (the covariate does not influence the final result)</td>
<td>No effect (r=0.216) (r must be greater than 0.3 at least)</td>
</tr>
<tr>
<td>Physics 1 / 2012-2013</td>
<td>totally YES (the covariate influences the final result)</td>
<td>Average effect (r=0.586, p=0.000)</td>
</tr>
<tr>
<td>Physics 2 / 2012-2013</td>
<td>totally YES (the covariate influences the final result)</td>
<td>Average effect (r=0.562, p=0.000)</td>
</tr>
<tr>
<td>Physics 1 / 2013-2014</td>
<td>totally YES (the covariate influences the final result)</td>
<td>Strong effect (r=0.653, p=0.000)</td>
</tr>
<tr>
<td>Physics 2 / 2013-2014</td>
<td>totally YES (the covariate influences the final result)</td>
<td>Weak effect (r=0.465, p=0.000)</td>
</tr>
</tbody>
</table>
Discussions (1)

• (1) There is a strong tendency to change the admission score distribution corresponding to the two samples, from a normal distribution for the year 2011 to lognormal or Weibull (right-centered) distribution, for the years 2012-2013 and 2013-2014.

• (2) These correlations are no longer highlighted in the summative assessment carried out for the control sample, except for the first year of analysis, where some correlation can be seen between the distribution curves of the admission means and those of the evaluation of Physics 1 and Physics 2, where the overall distribution is normal.

• (3) The summative assessment carried out for the experimental sample reveal a significant correlation (the two curves are virtually identical) between the statistical distribution of the admission means and the final evaluation means.

• (4) There are no statistically significant differences induced by the teaching strategy used for the academic year 2011-2012, the first year of the time interval which was studied.

• (5) There are statistically significant differences induced by the teaching strategy used for the next two academic years, respectively for 2012-2013 and 2013-2014.
Discussions (2)

- (6) The size of the induced effect varies between a weak effect ($r = 0.465$, Physics 2, 2013-2014) and a strong effect ($r=0.653$, Physics 1, 2013-14); the oscillations also show mean values between $r=0.562$, Physics 2, 2012-13 and $r=0.586$, Physics 1, 2012-2013.

- (7) Interestingly, the size of the induced effect, the whole process of learning physics, is not an upward trend, either from one academic year to another or from one subject to another (Physics 1, Physics 2). Overall, the size shows a fluctuating trajectory, with two average debuts with decreasing sizes in the same academic year from the first to the second semester ($r=0.586$, Physics 1, 2012-2013; $r=0.562$, Physics 2, 2012-2013), followed by a strong effect ($r=0.653$, Physics 1, 2013-2014) and a weak one ($r=0.465$, Physics 2, 2013-2014) in the last year of the experiment, from the first to the second semester.

- (8) The analysis of each academic year of the evolution of the effect size induced by the teaching strategy on the academic outcomes shows in the year 2012-2013 a decrease in the effect between average limits of 4% from the first to the second semester, and in the year 2013-2014 a decrease of the induced effect from strong to weak of 28.8 % from the first to the second semester.

- (9) Interesting differences are also indicated for the size of induced effects on each of the two studied subjects. Whereas for Physics 1 the size of the effect induced by the teaching strategy increased from 2012-2013 to 2013-2014 by 11.4 %, changing the reference interval (from an average effect to a strong one), in Physics 2, there was a decrease in the size of the induced effect over the two years of 17.3%, also changing the reference interval (from an average effect to a weak one).

- (10) The increase of the induced effect for Physics 1 is relatively equal to the decrease of the induced effect for Physics 2.
Coclusions (1)

• (1) The teaching of physics by using interactive strategies opens a wide field of possibilities for teachers’ effective and attractive intervention. The teaching method is a crucial factor which affects the learning outcomes [16].

• (2) Given that the two samples of students had roughly the same level of knowledge when starting the experiment, their academic performances were not optimized by the "interactive teaching strategy" variable. Similar results were also confirmed by other studies centered on the investigation of the effect the teaching method has on students' academic performance [17].

• (3) Apparently, the interactive strategy is less efficient than the classical one, because the academic performances obtained by the students from the experimental group were lower than those of students from the control group.
Coclusions (2)

• (4) However, the data obtained in the experimental group's summative assessment should not be interpreted as denoting weaker performances but as a more accurate assessment of students' performance, for the following reasons:
  • a. the pre-test data represent an objective reference system (for both samples);
  • b. the formative assessment was done by new technologies in learning through an interactive strategy in the two semesters when physics is studied;
  • c. the weight of the formative assessment results in the final assessment is 40% (see the data presented in the Introduction).

• (5) The aim of the experiment was reached (the effects of using interactive strategies in teaching physics to students in technical education were identified and analyzed and their academic results were assessed), all objectives were achieved, and although the specific hypothesis was not confirmed, the general hypothesis was validated.

• (6) The data indicate that the “interactive versus traditional teaching strategies in physics” dilemma from which our study started was not resolved. Interactive strategies may produce better results than classical education, but not in all conditions. On the other hand, students' academic performance can be more accurately identified, more completely measured and more precisely quantified by interactive experimental assessment methods.
ACKNOWLEDGEMENTS

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COMPLIANCE WITH ETHICAL STANDARDS

• The studies were approved by the Engineering Faculty Council at Vasile Alecsandri University of Bacau (formal request number.4348 dated 11 November 2014) and all procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. In order to comply with the informed consent requirement, all the identifying characteristics of individuals were removed and only neutral minimal data retained to preserve scientific integrity.
REFERENCES


