A HYBRID APPROACH IN A FIRST COURSE OF STATISTICS

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ABSTRACT

At the moment an intense debate is taking place on the form in which we teach in the classrooms in the different educational levels facing two conceptions: the traditional one against the innovative one. The debate about what and how to teach takes on special relevance when we teach quantitative subjects in careers with a non-quantitative profile such as Business Administration degree and with academic curricula that have gone from five to four years. Additionally we must also add that the current student arrive at university with new psycho-social characteristics make the traditional tools available to us obsolete, this inevitably means that we have to adapt to the new framework. For this, we propose a design of the classes based on a combination of: 1) a set of traditional strategies and materials, 2) a set of multimedia tools 3) a set of learning techniques based on the concepts of neuroscience (neuro-education) and finally 4) the implementation of flipped classroom. The empirical results show: with regard to students: 1) better average grade, 2) lower variability grades and professors received better general assessments at the end of the course about the dynamics of the class.

Keywords: Hybrid approach, video-lessons, screencast, neuro-education, flipped classroom, cooperative learning.

INTRODUCTION

At the moment an intense debate is taking place on the educative system about which model must be developed in the classrooms, in all the levels, from primary, secondary and higher education. Traditional models against more innovative models (flipped classroom). Most opinions or works face both teaching models comparing the advantages or disadvantages of each one of them. In this work we consider that both approach are not exclusive but complementary, proposing a combined or hybrid approach that contains some
traditional techniques that we believe are beneficial. At the same time innovative techniques are applied. On the one hand, these new techniques allow us a better adaptation to the characteristics of current students. On the other hand, allow us to develop important skills, such as creativity, initiative or cooperative work in which the traditional model failed.

The great majority of university professors are vocation professionals, that is, we are concerned about the future of our students and we see education as a social good that generates positive externalities for society in economic terminology. In this sense the main concern is how to get our teaching to have a permanent and positive impact on the lives of our students and therefore in society. Currently, for both students and teachers, the teaching of statistics, mathematics or econometrics is a constant challenge, Dillon (1982) especially in degrees as Business Administration or Economics with a reduce quantitative burden. It is worth noting two additional problems faced by a teacher of quantitative methods in these degrees:

1. Students come from high school with a negative bias towards quantitative subjects.
2. The shortening of the mathematics curricula as a result of adaptation and convergence to the European Education System (Bologna process) has produced a reduction of quantitative burden. For example, in Business Administration, Econometrics has passed from three subjects: Introductory Econometrics, Econometrics I and Econometrics II to only one Econometrics.

Additionally, most students show a set of common problems:

1. Lack of motivation.
2. Attention deficits.
3. Very low levels of frustration.
4. Lack of previous basic mathematical knowledge.
5. Strategic behavior. This specific behavior is related to the so-called bulimic students. Students, who try to “swallow” the subject in a week (or less) and immediately after the exam they “vomit” the knowledge. This behavior is particularly important when they will need this knowledge for future subjects
6. Difficulty in understanding abstract concepts.

The origin of the first three problems seems to have a cause, more or less clear, the incorrect use of technology as well as the extraordinary need for the immediacy of students with a lack of patience necessary for the learning process, especially in this type of subjects where it is necessary take time to reflect. The cause of the last two points could be more complex to identify but again the misuse of technology could explain part of the problem together with many changes in the Spanish educational system (many different plans depending on the part in the government) or socio-cultural changes.
Metodologías e innovaciones docentes

Lo que importa es no sólo el contenido que se transmite diferentemente, sino también la forma en que lo transmitimos. Aunque los métodos pueden ser variados, el objetivo es el mismo: facilitar el aprendizaje efectivo para que el estudiante pueda adquirir conocimientos sólidos y significativos. En este sentido, las innovaciones docentes no son solo una opción, sino una necesidad.

El diagrama muestra cómo las dificultades en el aprendizaje pueden generar déficit de atención, lo que a su vez puede llevar a comportamientos malos y expulsiones, lo que, en última instancia, genera un círculo vicioso difícil de romper.

En el contexto de la educación actual, es crucial implementar nuevas herramientas y técnicas que complementen los métodos tradicionales. En este sentido, se propone un enfoque combinado o híbrido con dos objetivos principales:

1. Utilizar al máximo las ventajas de la enseñanza tradicional incorporando nuevas técnicas pedagógicas y medioles tecnológicos que permitan desarrollar un proceso de aprendizaje más eficiente y efectivo.
2. Adaptar el proceso de aprendizaje a las nuevas características psicológicas y sociológicas de los nuevos estudiantes.

El objetivo final es crear un aprendizaje efectivo que permita al estudiante adquirir un conocimiento profundo de los temas que estudia, evitando el denominado estudiante bulímico.
METODOLOGY

As we have commented, we think that it is positive to preserve part of the traditional method of learning. We maintain the use of a wide range of basic textbooks, a set of slides developing the whole subject, a set of problem sets with solutions and finally a set of summaries of each topic. But we have included new material and new learning techniques that complement the traditional material: Multimedia tools, neuro-education concepts and flipped classroom techniques.

The structure of the course per week (Table 1) is composed of three sessions each week of one hour and a half with a total of fourteen weeks. The number of students per class is around 50 students. Roughly 60% of the classes (hands-on sessions and computer lab) are split in groups of 25 students. Each session is composed by: 1) pre-session work (readings of corresponding topic using the basic and complementary textbooks), 2) session materials (slides and technical notes), 3) work in class (this item includes short tests in Socrative or Kahoot about pre-session work readings or concepts of the previous sessions) and finally 4) post-session work (this item includes problem set of each session or computer exercises).

<table>
<thead>
<tr>
<th>Number of sessions per week</th>
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<tbody>
<tr>
<td>Session1</td>
</tr>
<tr>
<td>Duration</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Requirements</td>
</tr>
<tr>
<td>Work type</td>
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The work in groups try to implement the so-called collaborative learning. This type of learning is based on the view that knowledge is a social act. The
students solve different real-problems in small groups (4 or 5 students) in order to maximize their own and each other's learning.

**Multimedia Tools**

We are currently living in a world where technology plays a central role. A world where everyone and everything is interconnected. Generating what many authors have described as the third environment, the digital environment (added to the Natural and Urban environment). This new context or environment in which we move produces significant changes in the cognitive characteristics of current students therefore we must design a more efficient university education adapted to the new framework, Taylor (2010). A set of different multimedia tools have been made available to the students, Table 2.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Measures implemented in the classroom</th>
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<tbody>
<tr>
<td>Engage the unmotivated students</td>
<td>Short videos (video-lectures) that cover the whole subject (with apowersoft).</td>
</tr>
<tr>
<td>Consolidate the knowledge of students with medium and high motivation</td>
<td>Screencast for practical work (with apowersoft)</td>
</tr>
<tr>
<td>Cover the possible lack of assistance</td>
<td>Full use of Moodle or CANVAS: tests, forums, practices, etc</td>
</tr>
<tr>
<td></td>
<td>Kahoot, Socrative, Perusall,, etc.</td>
</tr>
<tr>
<td></td>
<td>Exercises on graphical tablet, etc.</td>
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During the experiment emphasis has been placed on the video-lectures, Woolfitt (2015), whose characteristics are the following:

1. Complementarity to traditional materials (not a substitute).
2. Flexibility. The student can watch the video whenever and wherever she/he wants.

About its technical characteristics (*SEA videos*):

1. Duration: 10-15 minutes (*Shorts*).
2. Explanation of basic concepts (*Easy*).
3. Practical exercises (only 5% for theoretical proofs) (*Applied*).

The main objective of the videos-lessons is to engage (short term), motivate and maintain interest (medium term) and consolidate (long term). The idea is that the student watch the video-lecturer online prior the class in order to minimize the lecture time in class (Wilson, 2013, Winquist, 2014).

Additionally the students have a set of screencast videos to carry out practices with computer using for that, free software like R (RStudio) or RCommander, and Excel. Also students have tutorials and a set of self-directed training exercises. The duration of this screencast is around 45 minutes and they were made with Apowersoft a free online application for: screen recorder, video converter, free screen capturer, etc. (https://www.apowersoft.com/).
Neuro-education concepts

Other tools that we have incorporated in the last course have been some concepts derived from neuroscience and applied to the world of teaching, called neuro-education. Neuroscience provides us with knowledge of how the human brain works that we can use and that we should use in teaching. However today there is no consensus on what is the true usefulness of neuroscience in the learning system. Neuroscience provides guidelines on how the brain learns through the link between emotion-cognition. The problem arises when we try to apply the neuroscientific knowledge in a classroom with 40 students interacting with each other and with the external environment at the same time. Always the reality is more complicated than the results obtained in a laboratory, that is, in controlled experiments. In any case, we think that neuroscience will not be the panacea for the actual problems in the classroom but it may help us solve or minimize some of them. Again, it will be a combination of neuro-education plus pedagogical techniques (Carballo, 2018).

The concepts of neurosciences applied to the classroom have focused on three points:

1. **Light the spark of curiosity**

This will lead to increase motivation and attention in class. In this sense, the following has been applied:

- A good exordium. Showing modesty, prudence, authority and domain of the subject. This introduction must engage to the student, what is Statistics for? Is it necessary? Answer these questions with attractive examples from the real world related to the student's daily life.

- Spill the theoretical explanations and the resolution of exercises with notes and historical anecdotes of the main authors (Ronald Fisher, Karl Pearson, etc.) who developed the subject.

- Motivate with real data.

In each topic we illustrate examples with real data mainly from four sources of data:

4. Our world in data (https://ourworldindata.org/).
We develop these examples in a section called the “Statistics in action” similar to the “Economy in action” in the Economy textbooks where real cases are shown.

![Statistics in Action](https://ourworldindata.org)

**Figure 2. Statistics in Action Slide**  
(Source: https://ourworldindata.org)

We show examples about: pensions, climate change, labor market, poverty, demography, sports (probability models to determine the probability of winning the champion league of each team), etc.

- New slides, more concise and more visual. For these types of degrees we try to avoid an excess of formulas. Proofs are available on campus virtual for the students who are more interested in the subject.

2. **The human brain learns by playing**

- Gamification that helps them consolidates knowledge in a fun way. We have used Socrative and Kahoot to carry out different tests during the course.

3. **Improve the relationship between student and teacher professor**

The relationship between teacher and student always has a relation of respect and authority towards the teacher. Working in a classroom where students admire and respect the teacher. The objective is transform the image of the traditional class (face to face relationship) into a more flexible relationship, similar to a trainer in a football team, that is, the elimination of blocks (teacher-student) and develop the class in a single block where the team moves in the same direction.

4. **Try to do the same as the so-called “extraordinary professor” Bain (2004)**
They have an intuitive compression of human learning. The extraordinary teachers know in depth the subject that teaches and they are informed of the latest knowledge. They are people who read (and in any way expresses it in class before the students) matters in fields very distant to their, which allows to address their explanations from very different points of view.

Try to emotionally involve the student during the class and provoke, with discussions, the clarification of some complex aspects of the same. They always show the student their interest not only because they learn and the success of their examinations, but because they understand the meaning of what is explained in class in order to have a deep impact in their life and personality. Make their students see that part of their success, as a professor, is the student’s own success.

**Flipped classroom and cooperative learning**

In this sense, what has been adopted is a more dynamic class structure where the student participates actively in the learning of the subject by solving practical group exercises, as well as the development of debates that promote the ability of analysis and collaborative learning, Reidsema et al. (2017) and Winquist et al. (2014). In order to encourage cooperative learning we use the resolution of exercises and tests in group in platforms such as Socrative, Kahoot or Perusall. Also we use free online sources to create mind maps in group for the different lessons of the subject as well as for the whole subject. That is, the student must do four mind maps: 1) about descriptive statistic (univariate and bivariate), 2) about probability theory, 3) about random variables (definition, graphics to represent a random variable, probability distribution for a discrete random variable and probability distribution for a continuous random variables and two-dimensional random variables). And finally a fourth mind map about the whole subject. The aim is to ensure that the student gets a clear idea about the structure as well as about the key concepts of the subject.
**EMPIRICAL RESULTS**

A simple comparative statistical analysis of equality of means has been carried out using Statgraphics Centurion with grades of two classes of Business Statistics I (using only traditional techniques and another class using a combination of traditional and new techniques) of 50 students each of them. We try to select two classes with similar characteristics, in term of average grades and percentage of females and males, in order to make the best possible comparison.

We denoted:

- TradClass = Traditional Class.
- NewClass = New class methodology.

Comparison of Means:

95.0% confidence interval for mean of TradClass: [4.9995; 6.1605]
95.0% confidence interval for mean of NewClass: [5.75843; 6.65757]
95.0% confidence interval for the difference between the means assuming equal variances: [-1.35306; 0.0970591].

t test to compare mean: Null hypothesis: mean1 = mean2 assuming equal variances: t = -1.71882  p-value = 0.0888041, therefore we do not reject the null hypothesis for alpha = 0.05.

With this sample we cannot reject then null hypothesis but we are very close to reject that both means are equal for a level of significance equal to 0.05.
Table 3. Descriptive Statistics for TradClass and NewClass.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>TradClass</th>
<th>NewClass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Average</td>
<td>5.58</td>
<td>6.20</td>
</tr>
<tr>
<td>Standard Dev.</td>
<td>2.04</td>
<td>1.58</td>
</tr>
<tr>
<td>Coeff. Of variation</td>
<td>36.60%</td>
<td>25.48%</td>
</tr>
<tr>
<td>Min</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Max</td>
<td>9.3</td>
<td>9.5</td>
</tr>
<tr>
<td>Range</td>
<td>8.3</td>
<td>6.5</td>
</tr>
<tr>
<td>Skewness</td>
<td>-1.63</td>
<td>-0.66</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.21</td>
<td>-0.89</td>
</tr>
</tbody>
</table>

Source: Own elaboration with Statgraphics.

Looking the box-plots (Figure 4) for both classes is clearly that grades are, in general, better in the NewClass with respect to the TradClass (greater median and greater mean and lower variability measure by the interquartile range).

CONCLUSIONS

- Although the statistical results are not robust because the number of experiments in too short (two classes) the final results are encouraging in favor of the hybrid method.
- The average grade is higher and the variability of grades is lower in NewClass.
- The minimum grade in the NewClass is greater than the minimum grade in the TradClass (3 point vs 1 points). The worst students get better grades in a NewClass.
The best students obtained, roughly, the same grades in both types of methodologies (≈ 9.5).

A better understanding of the structure and the basic concepts of the subject through the use of the mind maps in the NewClass (visual thinking).

The final surveys about the subject made by the students at the end of the course show their greater motivation with respect to the traditional classes.

The students valued the new implemented methods as very useful, especially video-lectures and screencast.

The teacher also obtained better general assessments about the teaching method.

REFERENCES


Metodologías e innovaciones docentes