HAS THE BOLOGNA PROCESS BEEN WORTHWHILE? AN ANALYSIS OF THE LEARNING SOCIETY-ADAPTED OUTCOME INDEX THROUGH QUANTILE REGRESSION

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1. **ABSTRACT:** This paper seeks to determine whether the introduction of new degrees under the EHEA has brought about any improvement in students' performance. To do this, first we build an index that covers student performance as a multidimensional variable (LEASO), and then taking as reference this index, we contrast the stated objective. Quantile Regression analysis is combined with a Least Squares Ordinaries (OLS) approach to estimate students' performance.

2. **RESUMEN:** El objetivo del trabajo es contrastar si la implantación de los nuevos grados dentro del EEES ha conseguido mejorar el rendimiento del alumnado. Para ello, en primer lugar se construye un índice que recoja el rendimiento del alumnado como variable multidimensional (LEASO) y posteriormente tomando como referencia dicho

índice se contrasta el objetivo planteado. Se analizan tanto los valores centrales como las colas de la distribución, para lo cual se recurre a la regresión por cuantiles.

3. **KEYWORDS:** academic achievement, composite index, EHEA, competences, continuous assessment / **PALABRAS CLAVE:** rendimiento académico, índice compuesto, EEES, competencias, evaluación continua.

4. **DEVELOPMENT:**

   a) **Objectives**

The first research papers have begun to be published on whether the implementation of the reforms introduced after the Bologna Declaration have resulted in improvements in students' performance (Pardo et al. 2009; Herrero and Algarrada 2010; Valveny et al. 2012). However these papers have tended to suffer from two limitations: they focus on a single dimension of performance (the final grades obtained by students) and they analyze improvements solely in terms of the average grades obtained (Mumford and Ohland, 2011). Our aim here is to produce an analysis in which both these drawbacks are overcome.

For the Learning Society the concept of knowledge needs to be redefined to take in a broader scope than has traditionally been the case. Although there have been papers that analyze other elements such as learning outcome indicators (Fernández et al. 2010; Andreu et al. 2012), there is none which offers an all-round view. Our **first objective** here, then, is to construct an index that can indicate student outcomes as a multi-dimensional variable within the Learning Society. We refer to this as the LEASO (LEArning Society-adapted Outcome) Index.

This instrumental objective enables us to address our **second objective**, which is to determine whether the introduction of new degree courses under the EHEA has actually improved the performance of students, as measured via the LEASO index. As stated above, this point has been analyzed in previous papers, but with two limitations: only one aspect of the outcome – students' grades – is examined and the analysis is based on the average

figures for the indicator used. This average-based estimation may fail to capture one crucial aspect: the fact that the changes introduced may impact differently on the performance of excellent students and that of average students (Eide and Showalter 1998). To overcome this limitation, our analysis is conducted via a quantile regression.

b) Description of my work

Building a Multidimensional Index of Students´ Outcomes

There are papers that cover elements such as student learning outcome indicators (Andreu et al. 2012; de Juana et al. 2012; Fernández et al. 2010), but none of them offers an across-the-board picture. We therefore set out here to construct a composite indicator that can provide a broader vision of the concept of knowledge that is better suited to the requirements of the Learning Society.

Here we follow the general assumption that there are a number of steps which need to be followed in constructing composite indicators (Nardo et al. 2005). These steps can be summed up as follows:

- Developing a theoretical framework and identifying and measuring relevant variables.

There are two basic approaches to assessing learning: direct and indirect. With the direct approach assessment is based on the demonstration by students of their knowledge or skills (Allen 2004; Martell 2007; Price and Randall 2008). By contrast, in the indirect approach students are asked to provide their opinions regarding their learning. Given that it is students who give meaning and utility to the learning that takes place, it is essential to obtain their opinions. Both types of measurement have their positive aspects, and the information that they provide is not mutually redundant, as the two types are usually only weakly correlated with each other (Kamphorst et al. 2013). As Smith et al. (2011) say, the consistent application of both direct and indirect measurements of learning outcomes is necessary to determine success on a course.

There seems to be no good reason to allocate more weight to one of these types of measurement than to the other, so they are weighted equally here.

Direct measurement, i.e. assessment by teaching staff, is divided here into two sub-categories (AUCC 1995): grades awarded via a final examination and continuous assessment over the year. We also distinguish between two sub-categories of indirect measurement, based on the approach used by Lizzio et al. (2002):

- Development of key skills. During the academic year, students develop a number of competences (González and Wagenaar 2003) which can be broken down into "instrumental competences" (cognitive and methodological skills), "systemic competences" (associated with the ability to see how the parts of a whole are linked and grouped) and "interpersonal competences" (associated with relationships with other people).

- Satisfaction. Most studies consider that teaching quality and student satisfaction are closely related (Guolla 1999; Sohail and Shaikh 2004; DeShields et al. 2005; Beecham 2009; Gibson 2010), so this should provide a good yardstick for assessing the learning process (Appleton-Knapp and Krentler 2006).

Figure 1 shows the outcome variables based on whether they are cognitive or non cognitive and on whether they reflect the viewpoint of staff or students.

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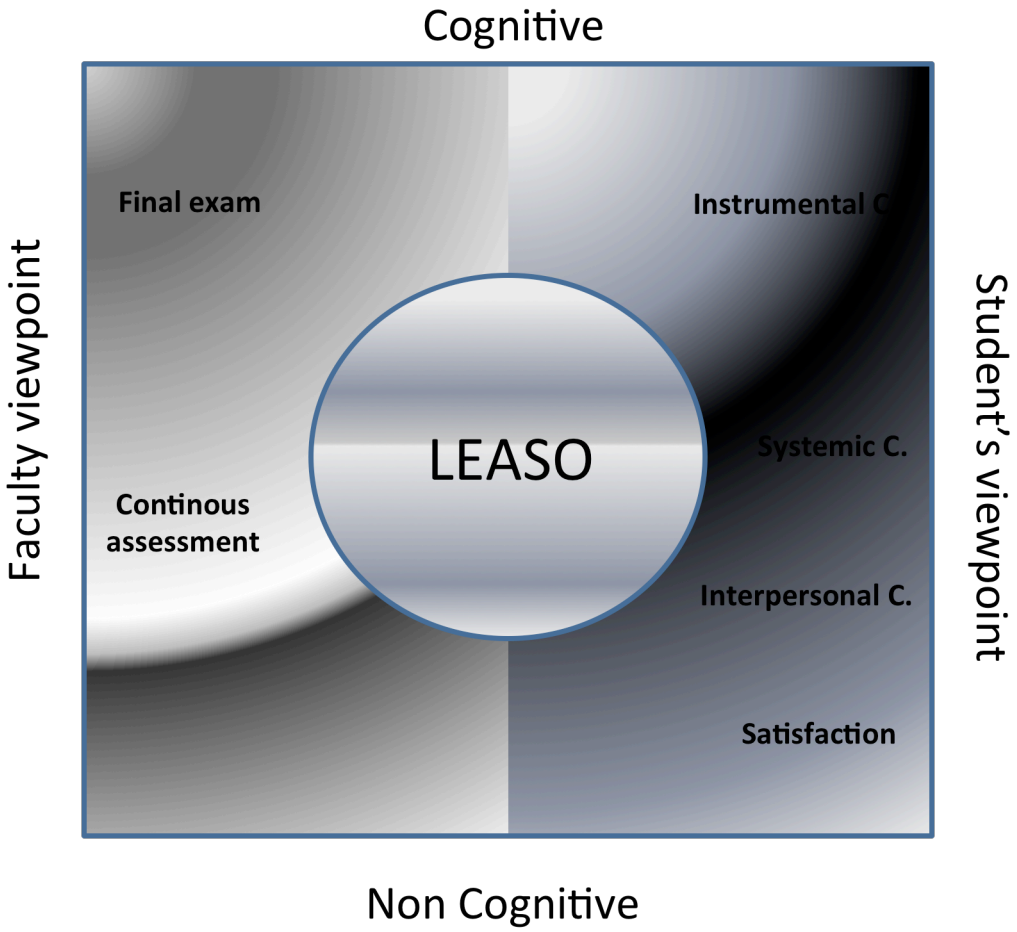
FIGURE 1: Variables that Make Up Students´ Outcome in the Learning Society



- Multivariate analysis.

First, a Principal Components Analysis (PCA) was performed to group factors together and thus reduce the dimensions of the dataset. After the explanatory factors were analyzed a confirmatory analysis was run to check the reliability and validity of the scales of measurement used (Hurley et al. 1997). The results are shown in Table 1.

TABLE 1: Factor Loadings and Descriptive Statistics

	Standardized weights	Mean	Standard deviation
INSTRUMENTAL COMPETENCES (Likert scale: 1- 5)			
P1: Management and administration of firm	0.770	3.63	0.720
P2: Application of principles of economic analysis	0.786	3.35	0.742
P3: Understanding of functional organization of a company	0.610	3.81	0.726
SYSTEMIC COMPETENCES (Likert scale: 1- 5)			
P4: Search for, collection, analysis and synthesis of information	0.776	3.50	0.873
P5: Learning ability (autonomous and continuous)	0.681	3.49	0.813
P6: Preparation and submission of reports	0.735	3.23	0.992
INTERPERSONAL COMPETENCES (Likert scale: 1- 5)			
P7: Teamwork	0.882	3.92	0.887
P8: Communication	0.882	3.90	0.826
SATISFACTION (Likert scale: 1- 5)			
S1: Work of the Faculty	0.787	3.41	1.051
S2: Content and subject matter	0.835	3.05	1.131
S3: Teaching method	0.675	3.32	1.026
S4: Assessment system	0.785	2.75	1.257
GRADE (scale: 0- 10)			
Final exam grade	0.912	5.15	1.574
Continuous assessment grade	0.462	6.11	2.661
Final grade	0.986	6.22	1.665

- Standardizing variables and weighting variables.

Standardization is required prior to any data aggregation as the indicators in a dataset often have different units of measurement. The standardization proposed for the simple indicators is:

$$I_{ji}^{h}=\frac{I_{ji}\text{-}\min(I_{ji})}{\max(I_{ji})\text{-}\min(I_{ji})}$$

This brings together the various indicators on a single scale (0 to 1), making it possible to integrate them into a higher order (composite) indicator in accordance with their relative variance.

Once the standardizing variables (I_{ji}^{h}) are identified, weights must be assigned to each one in order to calculate the composite indicator. Those weights must reflect the contribution of each indicator to the overall composite. The components are aggregated by weighting each composite using the proportion of the variance explained in the dataset (OECD 2008). The internal consistency of the indicators is assessed using composite reliability (ρ) and Cronbach's alpha. The average variance obtained is also calculated (Table 2).

TABLE 2: Internal Validity Measures

	ρ (composite reliability)	Explained variance	Average variance extracted	Cronbach's alpha
Instrumental Competences	0.919	52.760%	0.7220	0.547
Systemic Competences	0.922	53.044%	0.7307	0.554
Interpersonal Competences	0.885	77.805%	0.5880	0.714
Satisfaction	0.886	59.73%	0.5907	0.773
Grade	0.937	67.236%	0.7867	0.630

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This means that the LEASO Index for a student "i" is calculated via the weighting of the various constructs as follows:

$$LEASO_i = \begin{matrix} 0.5 \times Grade_i + \\ 0.5 \times [k_1(\text{Instrumental C.}_i) + k_2(\text{Systemic C.}_i) + k_3(\text{Interpersonal C.}_i) + k_4(\text{Satisfaction}_i)] \end{matrix}$$

Where k_j; j= 1,…,4 are calculated in terms of the proportion of variance explained by each factor.

Hypotheses & Grounding in Theory

Once the construction of the LEASO index is completed the next step is to test whether the introduction of new degree courses under the EHEA has actually improved the performance of students.

Tovar et al. (2007) analyze 94 experiences at Spanish universities and observe that the process of adapting to Bologna has entailed two major pedagogical changes in the teaching/learning process: new teaching methods and new assessment systems. Both are defined and designed in line with the competences to be attained (Martín-Peña et al. 2012):

- Active/collaborative methods. New, more participative, more collaborative teaching methods have been introduced that seek to focus on developing not just technical but also other types of competence (Gil et al. 2013; Fernandes et al. 2014). These active methods involving collaborative work have many advantages: they increase students' motivation (Burguillo 2010), facilitate more meaningful learning (Sinclair and Ferguson 2009), encourage critical and creative thinking (Barrett 2005), and promote interaction, thus honing interpersonal skills (Hmelo-Silver 2004).

- Continuous assessment. It must be stressed in regard to the changes in the assessment system is that assessment is an important issue that affects the whole of the teaching/learning process (Martínez-Lirola and Rubio 2009). Conventional assessment methods seek to assess the knowledge acquired at the end of the learning process. The need to assess that process itself has led to the development of

the continuous assessment system, in which there is more feedback between faculty and students and assessment becomes one more stage in the learning process. Many studies have recorded the benefits of such a system (Grimes 2004; Imam et al. 2011).

These new approaches developed in the EHEA are consistent with the requirements of the Learning Society, so final outcomes can be expected to improve.

The first hypothesis is therefore as follows:

H_1: The average student outcome has improved following the implementation of the Bologna process.

However, the average-based estimation made in H_1 may fail to capture one crucial aspect: the changes introduced may not have the same impact on performance for excellent students as for average students (Eide and Showalter 1998).

The collaborative work and active methods which are such mainstays of the Bologna process could result in greater improvements in outcome among excellent students, since part of the success of such methods lies in motivating students to take part in learning groups and to share ideas (de Graaff and Kolmos 2007), and it is excellent students who have the highest intrinsic level of motivation to learn (Yip 2007, 2009). However, a difficulty arises in the implementation of collaborative work: tasks are not always shared out equally among all members of the group (Macho and Elejalde 2013; Fernandes et al. 2014). Opportunist behavior may arise. Students with the potential to attain higher grades and levels of learning may be held back by the behavior and performance of other group members.

Continuous assessment systems entail a greater, more regularly-distributed workload for students than conventional assessment systems (Capo et al. 2013), which may have a negative effect on more irregular students. But they could also have the opposite effect: continuous assessment systems develop extrinsic motivation mechanisms linked to the

obtaining of a better grade that have been shown to be significant for students who take a superficial approach to learning, which is precisely the type of approach most widely observed among average students (Gargallo et al. 2012).

In view of the foregoing, this second hypothesis is put forward:

H_2: Student outcome has not behaved in the same way over the different levels of distribution.

Econometric Method

To check out the hypotheses put forward, we monitored the performance of the 596 students who took the subject "Business Management: Introduction" at the University of the Basque Country (Spain) in the last academic year prior to the implementation of the Bologna process (2009-10) and that of the 680 who took the same subject in the first year of its implementation (2010-11).

To obtain students' self-assessments a questionnaire was drawn up. 578 valid replies to this questionnaire were received: 232 for the pre-Bologna year and 346 for the Bologna year. This represents a confidence level of 95%, with a maximum error level of 3%.

To check for improvements in student performance, firstly we estimate a regression model by OLS (Greene 2008). As is well known, OLS results are focused only on mean performance. To obtain a broader picture we therefore also consider several different regression curves that correspond to various percentage points of the distributions and not only the conditional mean distribution, which leaves out the extreme points of the relationship between variables. Thus, a quantile regression method is applied.

c) Results and/or conclusions

As can be seen in Table 3, the improvement shown in the LEASO Index is statistically significant and its effect is positive, so the first hypothesis can be considered as validated.

TABLE 3: OLS Regression

	LEASO Index	Final Grade
Constant	5.58 (77.43)***	6.19 (56.27)***
Post-Bologna	0.45 (4.97)***	0.03 (0.19)

Note: t statistics in parentheses; * $p < .1$, ** $p < .05$, *** $p < .01$

A detailed analysis of the results shows that if the traditional method of considering only the final grade is used, no statistically significant improvement is found. The improvement shown according to the LEASO Index, which reflects the viewpoints of both faculty and students, is greater than that shown for the final grade, which reflects only the viewpoint of the faculty. This means that the changes introduced have led to major improvements in the opinions of students themselves concerning their learning and their degree of satisfaction.

Final grades essentially reflect technical knowledge, and the changes introduced have had no significant effect on the acquisition of such knowledge. However, the implementation of active methods has proved effective in developing systemic and interpersonal competences, which are recognized from the viewpoint of students themselves. Making students responsible for their own learning process has improved their motivation and satisfaction levels.

It must be pointed out that there are statistically significant differences between the figure obtained for the LEASO Index and the final grades of students (F=21.50; p-value= 0.000). It can therefore be concluded that the two indicators are not mutually redundant, i.e. that the LEASO Index contributes information not provided by academic performance alone. The definition and construction of an indicator such as the one proposed here is therefore a relevant exercise.

It is noteworthy that the gap between the figures for the LEASO Index and for final grades is narrower to a statistically significant extent after the implementation of the Bologna

process (F=55.41; p-value= 0.000). The other significant element in the process of change that came with the construction of the EHEA lies in the assessment system, which is now based on continuous or mixed assessment. The increase in the weight of continuous assessment in the wake of the implementation of the Bologna process has had two beneficial effects: first, the grade awarded by teachers is not limited to observations made at a single moment in time, i.e. the day of the final exam, but on evidence gathered throughout the academic year. To judge from the results, this has decreased the gap in the perception of results of faculty and students. The grade awarded at the end of a continuous assessment process is a better approximation of the actual learning achieved.

Secondly, in the context of the Bologna process assessment is formative in nature. It is not considered as an end in itself but a means to improve the teaching/learning process (Martínez-Lirola, 2009). This has two beneficial effects: on the one hand students obtain more feedback throughout the academic year, which enables them to recognize shortcomings, and on the other hand students are more motivated (Sewell, 2004).

Thus, although there are still differences between the way in which staff and students see things, the changes introduced are narrowing the gap between them. This indicates that the assessment system in place after the changes is fairer.

The 2nd hypothesis to be checked is whether students` outcomes behave similarly at different levels of the distribution. The LEASO Index reveals that the changes introduced have brought about improvements at all levels of the distribution (Table 4), with no statistically significant differences (F=6.21; p-value= 0.000), so the 2nd hypothesis put forward is rejected.

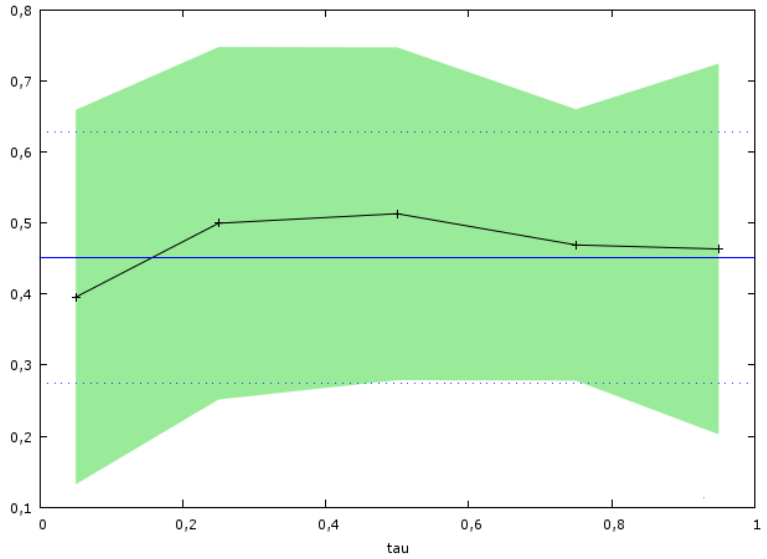
TABLE 4: Quantile Regression for the LEASO Index

	5%	25%	50%	75%	95%
Constant	3.74 (26.15)***	4.89 (42.33)***	5.63 (67.71)***	6.23 (67.86)***	7.24 (24.70)***
Post-Bologna	0.40 (1.92)*	0.50 (3.32)***	0.51 (4.96)***	0.47 (4.09)***	0.46 (1.49)

Note: t statistics in parentheses; * $p < .1$, ** $p < .05$, *** $p < .01$

As can be seen from Figure 2, the improvement in the LEASO Index increases steadily up to the middle levels of the distribution, i.e. up to those students who could be described as "average". From the midpoint onward the improvement in students' performance tails off, to the point where it is no longer statistically significant in the upper tail of the distribution (95% percentile), i.e. among "excellent" students. It can therefore be stated that the changes introduced have proved more beneficial to "less bright" and "average" students, and less beneficial to "excellent" students.

FIGURE 2: Improvement in the LEASO Index Following the Introduction of the Bologna Process



The use of collaborative methods has numerous advantages (Johnson et al. 1998), but when such methods are implemented difficulties arise which hit "excellent" students particularly hard. "Average" and "less bright" students benefit from collaborating with "excellent" students, while the latter have to dedicate part of their efforts to helping others, which robs them of time that could be spent on their own progress.

Moreover, as indicated above, students are more motivated with the new methods. "Average" students are initially less motivated, at least in areas of study which are not highly vocational, e.g. business administration, so the effect of the new methods on these students is greater. However, "excellent" students are already highly motivated, so any improvement can be expected to be small, with a contagious knock-on effect on "average" and "less bright" students. Opportunistic behavior is also more likely to arise among these students.

These factors explain why greater improvements are found among "average" and "less bright" students than among "excellent" students, i.e. why there is an asymmetric distribution effect in improvements in outcome.

The effects of the changes on the final grade variable can be described as uneven (Table 5): statistically significant improvements are observed only in the 25% percentile, i.e. among the "less bright" students. A statistically significant reduction can also be observed among "excellent" students.

TABLE 5: Quantile Regression of Final Grade

	5%	25%	50%	75%	95%
Constant	3.33 (9.65)***	5.23 (58.99)***	5.95 (26.26)***	6.15 (49.85)***	9.20 (38.71)***
Post-Bologna	-0.75 (1.85)*	0.32 (2.29)***	0.20 (1.27)	0.30 (1.19)	-0.69 (2.64)***

Note: t statistics in parentheses; * $p < .1$, ** $p < .05$, *** $p < .01$

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The new assessment system requires more regular effort, for which rewards and incentives are offered. This benefits "less bright" students, who are often less intrinsically motivated to study. Creating a system of incentives and other extrinsic motivation formulas is highly positive for such students. "Excellent" students (and to a lesser extent "average" students) are already more motivated and better disciplined, so they do not benefit as much.

"Excellent" students, i.e. those at the top of the distribution range for grades (the 95% percentile) are actually worse off in terms of their final grades. To obtain high grades students must now demonstrate not just one type of ability but several: under the traditional system the best grades went to those students who were capable of showing the greatest knowledge. These were not necessarily the students with the best social or organizational skills. To be an "excellent" student now, it is necessary to demonstrate a wider range of abilities, which means that the grades of those formerly classed as excellent suffer. The new system is more demanding.

A comparison of the results obtained with the LEASO Index and with the final grade system supports this argument. The increase in the value of the LEASO Index on the right-hand side of the distribution, with no significant increase in grades (and indeed with a decrease in some cases), means that "average" and "excellent" students consider that their level of acquisition of competences has improved substantially, even though the skills that they have thus developed have not raised their actual grades. Students therefore perceive the new teaching/learning methods and systems of continuous assessment as beneficial even when they do not necessarily have any direct effect on grades, because they take on board the idea that they are required to demonstrate a greater range of skills under the new system.

By reflecting the viewpoint of students themselves, the LEASO Index enables the degree of learning achieved by each student in comparison with their initial levels to be determined. Grades only indicate whether a student has reached a level set by a teacher. We therefore consider that the LEASO Index provides a broader view of learning for each individual student.

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