# The path towards the European Higher Education Area: case study based on a two-step course adaptation process

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**Abstract**

**Adaptation to the European Higher Education Area is a process requiring changes at several different levels. In terms of methodologies, these must progress from traditional style learning to an European Credit Transfer (ECTS) paradigm. However, solutions based on a mere adaptation of the course's contents to the new credit measurements could be counterproductive in terms of knowledge acquisition and student satisfaction. In this paper we propose a methodology to adapt courses by introducing carefully studied changes. Such methodology relies on a previous characterization of the student population in terms of learning styles by means of a web survey. Changes to the course are made according to a two-step strategy where, in a first step, we introduce a transitional period where optional evaluation methodologies are introduced to assess students' responsiveness. In a second step we introduce the final course format according to a feedback from first-step experiments. We believe that such a soft transition helps at improving the final decision in terms of methodological solutions adopted, thus allowing teachers to better control an often rough path.**

**Keywords**
ECTS, learning-styles, course adaptation.

## 1. INTRODUCTION

Being the widespread adoption of the European Credit Transfer System (ECTS) imminent, it is now time to analyze in perspective the process of adaptation followed by the different participants. This process includes methodology adaptations, assessment of the effectiveness of the efforts taken, and drawing of appropriate conclusions, using them as feedback for further improvements.

In a previous work [1] we reported a pioneer experiment at the Technical University of Valencia whose purpose was to assess the learning styles of our students. We based our study on a proposal by Felder and Silverman [2], which characterizes students according to four learning style dimensions: active/reflective, sensing/intuitive, visual/verbal, and sequential/global.

To assess the learning style of our educatees, we set forth a web-based survey involving students from Computer Engineering Degrees and a Degree on Documentation.

Using the information drawn from that previous study as our point of departure, in this work we present a two-stage adaptation methodology to gradually convert a traditional course from the Degree on Documentation – Information Organization and Networking – into an ECTS-style course. The adaptation methodology makes special emphasis on changes to theoretical and practical classes, as well as to evaluation, which is the main promoter of change. In the first step we have made several experiments to assess the responsiveness of students and their effectiveness in terms of improving the learning process. In the second step, and based on the information gained from step one and from our survey, we proceed with a complete

reorganization of the course in terms of both structure and evaluation. In this paper we will describe in detail the entire process, emphasizing on those issues we consider most relevant and novel. We consider that the proposed methodology can be applied to any other course of the degree, as well as to any other degree in a straightforward manner.
This document is organized as follows: in the next two sections we provide all the required background, setting the scientific basis for our subsequent analysis. Hence, in section 2, we introduce the learning style theories developed by Felder and Silverman. In section 3 we briefly present the results from our survey on learning styles, allowing the reader to better understand the discussion that follows. Section 4 is the core of this paper, where we introduce a two-step methodology proposed for upgrading a course from a traditional style to an ECTS style. Finally, in section 5, we draw the conclusions of this work,

## 2. THEORY ON LEARNING STYLES

The learning style basically determines the preferred way for students to learn. Hence, by knowing the students' learning styles, instructors can fuel up the learning process by selecting the appropriate methodology.
Several authors [3-7] have focused their research on the learning styles of students. Authors such as Witkin [3] relate the learning style to the physical characteristics of the individual, especially to the dominant quadrant of the brain, defining four learning dimensions. Other works, such as that of Swassing et al. [4], relate the learning style to the information representation system, defining three learning dimensions. Gardner and James [5] associate the learning style to the type of intelligence, defining nine different learning dimensions. Finally, authors such as Kolb [6] focus on how information is processed. These authors propose using four learning dimensions, though there are some differences between both proposals.
The work done by Felder and Silverman [2], and in particular on the four dimensions they have defined, are a reference in terms of theoretical modelling of the learning process, being used as a basis for the current study. Hence, we now proceed by defining in more detail each of the dimensions they have proposed.
With regard to the first dimension (active/reflexive), active learners prefer practical activities, interacting with the outside world based on information gained through group works. Reflexive learners prefer to do an exam or some sort of mental processing of information gathered by them.
The second dimension (sensitive/intuitive) allows distinguishing between sensitive learners that prefer to memorize data and solve typical problems through standard procedures (sensitive), from intuitive learners that prefer to seek for solutions to novel and complex problems by applying principles and theories. Moreover, the former acquire new concepts more easily.
The third dimension allows differentiating visual and auditory learners. Visual learners prefer visual information since their retention and comprehension is improved. Auditory learners are on the opposite pole, and therefore must listen to information, besides verbalizing them (for example, explaining the concepts to others) in order to improve comprehension.
Finally, the fourth dimension distinguishes between sequential and global learners. Sequential learners prefer information to be presented gradually, and by increasing order of difficulty, usually following a linear line of reasoning to solve problems. Global learners prefer than certain complex concepts are presented beforehand, thus obtaining a global vision of the existing interrelationships. Once concepts are assimilated as a whole, global learners are able to synthesize them more easily which allows them to solve more complicated problems.

## 3. BACKGROUND WORK

In a previous work, and based on a survey initially proposed by Felder [8], we were able to characterize our students according to the four dimensions proposed by this author.
Felder's questionnaire relies on a total of 44 questions. Each question has two options, which are related to the different learning styles for a same learning dimension. So, the score obtained on each answer is assigned values of either -1 or 1. At the end of the questionnaire, and for each learning dimension, the scores obtained are added up. This means that score values are in a range that goes from -11 to 11, and that only odd values are possible.

**Table I. Characteristics of the student population under analysis**

| University career | Degree on Technical Informatics | Degree on Informatics | Degree on Documentación |
|---|---|---|---|
| *Numerus clausus* | 400 | 150+50 | 75 |
| Number of students | 2156 | 1320 | 227 |
| Number of participants | 119 | 245 | 36 |
| Participation ratio | 5,5% | 18,6% | 15,9% |

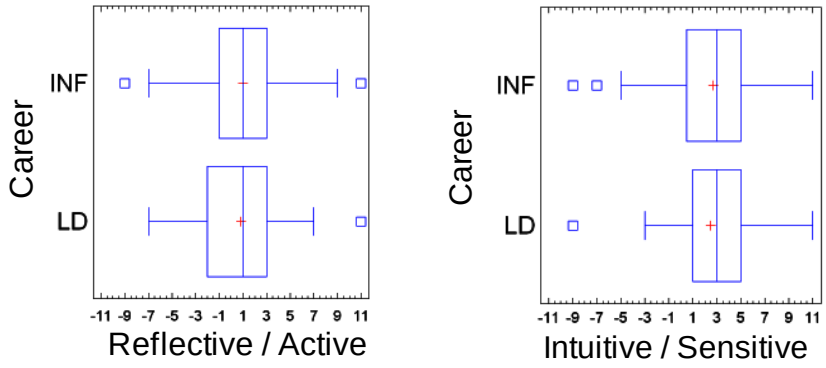


**Fig. 1. Box plot for the active/reflective dimension (left) and the sensitive/intuitive dimension (right).**

We developed a fully automatic web survey system, based on Felder's, accessible from any terminal with Internet connectivity to reach all students in a simple and straightforward way. Moreover, the generation, storage and later treatment of data can be made automatic, saving both time and paper resources.

Our survey involved students from two different degrees on Informatics and a degree on Documentation. The characteristics of the student populations under analysis are shown in Table I. In the analysis that follows we grouped students from both degrees on Informatics since they present similar characteristics.

With respect to the first dimension, Figure 1 (left) shows a box and whisker plot with the results obtained for both groups of students. Tags INF and LD refer to students from the degrees on Informatics and Documentation, respectively. The box plot shows the values between the first and the third quarters, being the median represented by the line dividing the box in two. The cross represents the mean, and the square near the edges represents atypical values (outside the range of normal values as defined by the box).

Statistical data show that the median and variance are similar for both student populations, though there is a better equilibrium for students of the degree on Documentation. As can be observed, in both cases there is a slight trend towards active learning methodologies. Such methodologies are currently experiencing great emphasis due to the changes introduced by the European Higher Education Area. Hence, we consider that such efforts are being conducted in the right way. Nevertheless, we should take into account that purely active methodologies are not the adequate solution and, therefore, an equilibrium between both methodologies must be sought when attempting to increase the effectiveness of the learning process by students.

With respect to the second learning dimension, Figure 1 (right) shows that, for this dimension too, there are strong similarities between students from both degrees, despite the presence of students leaning towards intuitive learning is more frequent in Informatics.

On the other hand, we should point out that, in both cases, about 50% of students show a lack of balance, leaning towards sensitive learning (information recollection). For a 25% of them the trend is quite worrying since it surpasses the 5 point threshold.

The small differences detected between both student populations are logical since it is expected that an engineers have developed more skills that allow them to use what they learned in completely new contexts, something not required for students in the Degree on Documentation.

Globally, we consider that the trend towards sensitive learning is quite worrying, and must be countered through adequate learning processes so that students evolve in terms of intuitive processing of information, thereby achieving the desired balance.

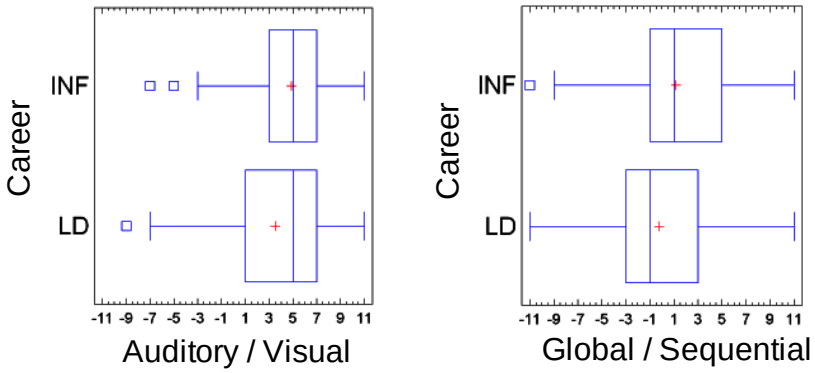


Fig. 2. **Box plot for the visual/auditory dimension (left) and the global/sequential dimension (right).**

Regarding the visual/auditory dimension, Figure 2 (left) shows clear differences between both student populations. In both cases, though, there is a strong trend towards visual learning. Moreover, for Informatics students, we find that it is difficult to find learners that prefer auditory information instead.
Globally we consider that, for this dimension in particular, the characteristics of students must be taken into consideration with the risk, otherwise, that they do not achieve the desired degree of comprehension and knowledge assimilation.
Finally, with respect to the last learning dimension (sequential/global), Figure 2 (right) shows that there are clear differences between careers. On both cases we are able to find students having difficulties to learn with one style or the other, which can be problematic when trying to set an optimum common strategy for classes.
In summary, we have analyzed the learning styles of students from two heterogeneous knowledge areas, finding that their characteristics are, in general, rather similar, being that a significant number of students presents learning problems in face of class styles strongly biased towards intuitive and auditory learning.

## 4. PROPOSED TWO-STEP COURSE ADAPTATION PROCESS

In this section we describe the process we followed to adapt a traditional course from the Degree on Documentation – Information Organization and Networking – to an ECTS course according to the guidelines defined by the European Higher Education Area (EHEA).
Instead of adopting a radical transition from a traditional educational paradigm to an ECTS style course, we preferred to do it in two steps. In the first step we introduced several small changes to assess the responsiveness of students to different methodologies. Based on the feedback obtained from that process we then devised the most appropriate strategy to adopt for the second and decisive step. The choice on which methodologies to use on both steps depended heavily on the results of our survey on students' learning styles, which helped at identifying possible issues that could result as problematic.
We now briefly describe the course being adapted in terms of traditional contents and methodology. We proceed by detailing the changes introduced to the course on both steps of this process, evidencing the relationship between the methodologies introduced and the conclusions from our learning styles survey.

### 4.1 Course description

Information Organization and Networking is a course of the 10$^{th}$ semester in the Degree on Documentation. The number of students is typically reduced (between 10 and 20), which facilitates the introduction of active methodologies and alternative evaluation techniques.
Its learning goals include and understanding of the functioning of the Web and the Internet, with emphasis on the different protocols involved in a client-server interaction.
The course is organized in five units as follows:

1. Computer networks and communication protocols
2. Basic applications in the Internet
3. Internet and the WWW
4. Client-side programming: HTML and Javascript
5. Server-side programming: ASP and PHP

Classes are organized in three types: theoretical classes, practical classes and laboratory sessions. Theoretical classes (2 hours/week) follow the standard lecturing approach, which are complemented by class practices (1 hour/week) where students use computers to solve small exercises that are quite meaningful in terms of knowledge assimilation. In lab sessions (2 hours every 2 weeks) students are guided to solve more elaborate problems based on the knowledge acquired on both theoretical and practical classes.
Concerning evaluation, it traditionally relied solely on a final exam that includes questions about all the course's contents. The characteristics of the course described up to now apply to all the academic years previous to the transition process promoted by the EHEA.

## 4.2 Step 1: probing student's responsiveness to new methodologies

Probing students for their responsiveness to novel methodologies is important to avoid introducing activities that do not offer the desired reward in terms of knowledge acquisition. Therefore, taking as reference the original course style, quite traditional in terms of contents and teaching style as referred above, the first stage of the adaptation process introduced gradual changes, proposing optional tasks with an emphasis on active methodologies.
By analyzing the characteristics of the five course units defined in the previous section, we identified two areas requiring a different treatment: units 1 to 3, more theoretical, and units 4 and 5, more practical. Accordingly, we proposed two different tasks:

Task 1. A research work on a field related to the course (units 1 to 3).
Task 2. Design of a web page involving uploading data from the client to the web server (units 4 & 5).

While the first task adapts perfectly to the theoretical nature of units 1 to 3, the second one is obviously practical as required. Both consisted in autonomous works that full under the category of active learning methodologies. Our choice was based on the EHEA guidelines and on the results of our survey related to the active/reflective dimension. We found it was effective at making students more participative in the class (90% of assistants), and also promoted learning. Since, as shown in section 3, a significant amount of students prefers reflective learning instead, we offered the possibility of doing these works alone or in groups, thereby improving adaptation to both learning styles. In fact, while some of the students were enthusiastic about group work, others showed great relief by having the possibility of doing it alone.
For the first work, based on research of a related topic, presentation and defense before the class group was mandatory. The purpose was to promote auditory skills in those students presenting the work, a skill that was shown in section 3 to be often scarce.
This first work was evaluated by both students and teacher. Evaluation between peers is common in the research field and often at companies too, and so we considered that this sort of responsibility should be promoted while still at the university.
One of our dilemmas was how to make the effort required by this first work attractive to students in terms of final score, while maintaining the possibility of being evaluated through a single final exam (requirement of the educational center). After considering several different possibilities, we opted for an additive approach to the score: the work allowing adding up to 20% to the final score. We confirmed that such a generous strategy was indeed effective at getting students involved.
The second task, practical and autonomous by nature, directly replaced one of the questions in the exam. This strategy was successful too, being that all students attending classes participated in such works.
Finally, we surveyed the students from this course to have a feedback on their experience, emphasizing the new activities introduced. About 90% of students participated, and the overwhelming majority expressed their satisfaction about taking part in the proposed activities.

## 4.3 Step 2: transition to ECTS

Based on the experience acquired from both the first step experiments and the results from our survey on learning styles, we took a decisive step in transforming the course by eliminating the final exam and basing evaluation mainly on the work done by students throughout the course. This requires adapting the whole course to the new scenario, and completes the transition process towards an ECTS style course in terms of methodology.

One of the challenges involved was finding evaluation methods that adapted to the course's characteristics. To evaluate the more theoretical part of the course the strategy adopted in step 1 was not appropriate since our purpose was to evaluate the understanding of the whole class material (instead of a specific research topic). So, we preferred using conceptual maps [9] instead. These we are able to grasp the degree of understanding that students have about the different concepts involved, and allow scaling up without much effort. Besides, the survey on learning styles shows that most students are prone to sequential and sensitive learning, a trend that we consider should be somehow countered. Development of conceptual maps forces students to gain a global vision of concepts for their execution, and also promotes intuitive learning. Hence, we consider that they positively affect the learning process.

For this endeavor we recommended using the CMAP tool [10] because it is freely available for different platforms, and also because it is specifically designed to support development of conceptual maps. In terms of evaluation, we measured the accuracy, complexity and completeness of the conceptual maps designed by students. These maps accounted for a 40% of the final score obtained in the course.

Concerning the practical part of the course, it was evaluated through a case study. The use of case studies in education has proved to be an adequate strategy [11-12]. Also, they are one of the best alternatives to enforce active learning processes. In order to fully integrate the case study with the course's activities we altered the lab sessions contents so that they now focus exclusively on developing the case study proposed. That way we were able to decrease the amount of autonomous work at home, while increasing the participation in the lab sessions.

Since the course units related to the case study were only presented near the end of the course, we had to reorganize their order of presentation in theoretical classes to accommodate to the new requirements. So, the course is now organized as follows:

1. Basic applications in the Internet
2. Client-side programming: HTML and Javascript
3. Server-side programming: ASP and PHP
4. Internet and the WWW
5. Computer networks and communication protocols

In terms of concepts related to computer network layers, we initially followed a bottom-to-top approach, which had to be dropped in favor of a top-to-bottom approach. Since concepts are still presented in a sequential manner, we consider that this option does not affect students with either sequential or global learning styles.

In terms of score, the case study accounts for the remaining 60% of the degree obtained in the course.

Concerning results, we experienced a high degree of participation, being that the number of drop-outs was maintained at values close to those of previous years. In terms of mean score, we did not appreciate any significant differences in neither of the steps, with the advantage that the know-how demonstrated by students by the end of the course is now significantly higher compared to previous years, especially in terms of web development.

## 5. CONCLUSIONS

In this paper we presented the process followed to adapt the course *Information Organization and Networking*, belonging to the career *Degree on Documentation* of the UPV, from a traditional style to an ECTS style according to the guidelines of the European Higher Education Area.

To accomplish our goal we first surveyed the student population to assess their learning styles according to a taxonomy proposed by Felder and Silverman. We then proceeded to adapt the course in two steps (two consecutive years). In a first step we introduced optional works related

to active learning methodologies with a probing purpose: assessing the responsiveness of our students. The success experienced in terms of participation ratio and survey results motivated us into proceeding to the second and final step, were we the final exam was eliminated. Evaluation relied instead on two autonomous works. To handle the acquisition of knowledge of a more theoretical nature we proposed developing conceptual maps. Practical skills in terms of web programming were evaluated through a case study developed in laboratory sessions and at home.

Overall, we are greatly satisfied with the results obtained and the degree of student participation, and we recommend other teachers to follow such a systematic approach to guarantee their success in similar endeavors.

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