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Practical implementation of the European Higher Education Area directives in horizontal, inter-curriculum courses

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Abstract

This paper discusses the challenges involved in implementing the "Bologna" participative, student-centric, outcomes oriented methodology in horizontal subjects spanning multiple degrees and therefore a large number of students and groups. It analyzes the implementation project of an Engineering Management course which will be offered in several Bologna-compliant engineering degrees in the Universidad Carlos III de Madrid starting September 2009, and that is scheduled to be offered in over 30 groups per year by 2011. After analyzing the current implementation status of the European Higher Education Area in Spain and its methodological implications and challenges for high volume courses, the pilot projects carried out in preparation for this transition are examined. Based on them, the institution-level and course-level design approaches taken are discussed, in terms of how they address these challenges and which specific stumbling blocks must be overcome. Several complementary approaches that can facilitate the implementation process are then analyzed. It is concluded that careful advanced planning and testing, along with the facilitating approaches analyzed in this paper and the exploitation of synergies between research and education can increase the likelihood of a successful transition.

Keywords: Bologna, EHEA, core courses, participative methodologies, curriculum development

1. The EHEA ("Bologna") process

The so-called Bologna Process is named after the Bologna Declaration, signed in 1999 by the education ministers from 29 European countries (Wachter, 2004). Today, the Process unites 46 countries belonging to the European Cultural Convention. Its overarching goal is the creation of a European Higher Education Area (EHEA) based on international cooperation and academic exchange that is attractive to European students and staff as well as to students and staff from other parts of the world. It involves major reforms in the higher education systems, including:

- Easily readable and comparable degrees organised in a three-cycle structure (e.g. bachelor-master-doctorate). Countries are currently setting up national qualifications

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frameworks that are compatible with the overarching framework of qualifications for the European Higher Education Area and define learning outcomes for each of the three cycles.

- Quality assurance in accordance with the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG).
- Fair recognition of foreign degrees and other higher education qualifications in accordance with the Council of Europe/UNESCO Recognition Convention.

Work is also undertaken in areas of broader societal relevance, such as the links between higher education, research and innovation, equitable participation and lifelong learning. Given the potential impact on the relationship between European and non-European higher education, a "Strategy for the European Higher Education Area in a Global Setting" has also been adopted.

The Bologna Process Stocktaking Report 2009 (Rauhvargers, Deane and Pauwels, 2009) analyzes the current status of participating countries, and Europe as a whole, regarding such criteria as: implementation of the three-cycle Degree System, quality assurance, recognition, lifelong learning and mobility and developments on the "Strategy for the European Higher Education Area in a Global Setting"

2. The "Bologna" process in Spain

The Spanish National Report submitted by the Spanish Government as an input for the Stocktaking Report 2009 provides information on the current situation in Spain regarding the EHEA implementation (Mora et al, 2009).

Even though logically written from the Government's perspective, it does acknowledge that "a major regulatory development process is currently underway". It also describes how "By virtue of Article 17 of Royal Decree 432/2008 of 12th April, which restructured Spanish government ministries, the Ministry of Science and Innovation took over responsibility for making proposals and implementing government policy on issues related to higher education...", a major change that has recently been reversed.

The report refers to Royal Decree 56/2005 of 21st January (on official postgraduate studies), which led to the first EHEA-compliant postgraduate degrees, and to Royal Decree 1393/2007 of 29th October, which regulates the organisation of official university education and develops the new structure. This new system structure encompasses:

- First cycle (Bachelor) studies after completing 240 ECTS credits.
- Second cycle (Master's) studies after completing a further 60 to 120 ECTS credits.
- Third cycle (Doctoral) studies lasting between 3 and 4 years.

The first EHEA-compliant bachelor degrees started in September 2008, among substantial controversy. 33 Spanish public and private universities, out of the 75 existing ones, offered 163 programmes; 200 proposals had been presented to the Council of Universities and screened by the National Agency for Quality Assessment and Accreditation (ANECA). By Sept 2010, all bachelor degrees must be EHEA-compliant.

In Royal Decree 1393/2007, 5 broad "branches" were defined for undergraduate degrees: Arts and Humanities, Natural Sciences, Social Sciences and Law, Health Sciences, and Engineering/Architecture. Each undergraduate degree has to belong to one of these branches, and include at least 60 ECTS of "basic" courses. At least 36 ECTS of these "basic" courses should be on the topics listed for the degree's branch. For example, any

Engineering/Architecture degree should include at least 36 ECTS credits from physics, mathematics, computer science, business administration, graphical expression (i.e. technical drawing), and chemistry (Duran and Moon, 2008). No content guidelines were specified for master's level degrees in order to encourage universities to foster their unique specializations. Special degrees such as Medicine should be regulated separately from other degrees. Those degrees requiring certification for professional licenses such as engineering require additional content guidelines. These additional guidelines were not prescribed in R.D. 1393/2007; for engineering degrees, were only issued in February 2009.

Additional, far-reaching modifications in the Spanish educational system were introduced, such as replacing the previous government-approved closed catalogue of official engineering degrees by an evaluation and accreditation process whereby each university could propose whichever bachelor degrees it deemed appropriate. Therefore, these 163 new degrees were, for the first time, designed without a government-provided template (Moon and Duran, 2008).

3. EHEA- related curricular and methodological changes in the Carlos III University Engineering School

The public university Universidad Carlos III de Madrid (UC3M) submitted a proposal for the replacement of all its existing engineering degrees by the new ones by Sept 2008. After completing the ANECA review, 8 out of its 10 undergraduate engineering degrees had new enrolments in the first year discontinued for September 2008, and were replaced by bachelor degrees ("Grado en ingeniería").

This meant that all UC3M engineering degrees were simultaneously redesigned. Furthermore, as previously discussed the curricula for these degrees were, for the first time, designed without a government-provided template, subject solely to the condition (since they all belonged to the Engineering/Architecture branch) that they include at least 60 ECTS of "basic" courses, which in turn should include at least 36 ECTS credits from physics, mathematics, computer science, business administration, graphical expression or chemistry.

This created an opportunity to exploit synergies between degrees. A decision was taken at the UC3M school of engineering to design degrees belonging to the same "family" (industrial, telecom, computer science...) so that the first two years would be common. That should facilitate career path changes by students that modify their preferred degree after joining the university, allow the pooling of resources in areas such as offering English-based groups, etc. This initial decision was further developed by the introduction, in the Feb 09 decrees establishing the additional content guidelines for regulated engineering professions requiring professional licenses, of "family modules" (e.g., " Módulos comunes a la rama industrial"), that all degrees of the same family must include in their curricula, in addition to the basic branch-linked subjects. Since these additional guidelines were issued when the corresponding bachelor degrees were already being offered at the UC3M, some "retro-fitting" is currently being performed on the curricula to ensure they conform to the guidelines.

Furthermore, this led to the creation of some subjects, corresponding to the list of the Engineering/ Architecture basic topics, that spanned all the engineering degrees. The subject analyzed in this paper, Foundations of Engineering Management, implements the "business administration" basic topic, and spans 7 different engineering degrees, from Telecommunications to Mechanical Engineering. This being a core (not elective) subject, this will result in a large number of parallel groups being taught in any given academic year. Since the implementation of these undergraduate degrees started in September 2008, and this subject is taught in either 2nd or 4th year depending on the specific degrees, actual teaching will start in September 2009 in 4 degrees, and in September 2011 in the remaining 3. It may

also be extended to the remaining existing degrees once they are converted, as well as to new degrees.

Regarding methodology, the Bologna process was supposed to involve a significant shift from instructor-centred "teaching" to student-centred "active learning". This necessitates methodological changes such as implementing continuous evaluation schemes, de-emphasizing theory-only lectures, developing assignments and class projects, and encouraging hands-on experiences. It should also allow the students to design their own curricula with a higher level of flexibility.

It is worth noting, however, that European reports and documents on the Bologna process (such as the Stocktaking Reports in 2007 and 2009) do not devote a lot of attention to this "focus on learners", concentrating instead on the "focus on learning outcomes". The 2007 report highlighted the importance of adopting learning outcomes as the basis of the national qualifications frameworks, systems for credit transfer and accumulation, diploma supplements, recognition of prior learning and quality assurance. These "learning outcomes" refer not to the accumulation of knowledge but to the development of skills and competences, thus being related with the active learning methodologies (Moon, Sanchez and Duran, 2007). The 2009 report suggests that the shift to an outcomes-based approach to learning would support the EHEA goals in various areas: move the emphasis from providers of education and training to learners; increase the transparency of qualifications; introduce a common language that can reduce barriers between different education and training sectors and systems; support international cooperation, since learning outcomes focus on the profile and content of qualifications, rather than on the institutions that award them. It argues that the main end product of the Bologna reforms is better qualifications based on learning outcomes and not just new educational structures. It shows, however, that this transformation from using traditional input/content approaches to output/outcomes approaches to conceive, validate, monitor and express qualifications is proving slow and difficult.

In the last few years, the UC3M has been experimenting, learning and paving the way for these pedagogical changes while the legal framework was being finalized. Numerous initiatives have been launched to support these changes. Some groups were created for testing purposes and some degrees were chosen to extensively test out the new methodologies. The UC3M has funded a number of methodology adaptation projects and faculty training. New metrics for evaluating the faculty performance and a support infrastructure for the new pedagogical approaches have been developed. New degrees are expected to incorporate these new pedagogical approaches.

4. EHEA directives in horizontal, inter-curriculum courses. Challenges

Adopting the "Bologna process" student-centric, outcomes-oriented methodologies in these horizontal, inter-curriculum courses faces significant hurdles, particularly when budget constraints are taken into account. Tackling them requires achieving the educational equivalent of the current manufacturing trend towards "mass-customization", in order to allow individually tailored learning paths with a level of resources similar to that required by standardized education.

These challenges include:

- Resource constraints. This is a general, "umbrella" constraint that severely limits the approaches that can be implemented. "Craft-like" approaches that can be effective in the shift to a more active, participatory and student-centric methodology in smaller subjects can not be applied in this environment. Preliminary pilot results suggest that, unless course designs (and, particularly, evaluation procedures) incorporate elements specifically

aimed at allowing scalability, these approaches can not be properly implemented with the current resources. Besides the need for additional resources, in some instances the need is for different resources; e.g., smaller, multi-functional classrooms, in which students can be rearranged in several working groups, may be required.

- Faculty motivation and incentive structure. This challenge is not specific to the horizontal, high-volume multi-group subjects; however, it is more acute in these, since a large team of instructors must uniformly implement effort-consuming approaches. The ever present resistance to change is compounded in this case by a lack of identification, among a significant part of the engineering faculty, with the EHEA approaches, as well as by a research/ publications oriented recognition and incentive system that does not even contemplate student learning outcomes.
- Student motivation and cultural and institutional framework. For the shift to a student-centric active learning to actually occur, students must assume this active role. This cultural change requires an appropriate evaluation/ recognition system, and overcoming some stumbling blocks such as an institutional/ regulatory framework that may be interpreted as entitling students to achieve the maximum grade merely through the final exam, without participating in the continuous evaluation. That interpretation is widely held, particularly for the "second evaluation" or make-up exam to which students getting a "fail" grade are entitled, under the current regulations in the Madrid region.
- Homogenization vs. preserving initiative: When so many groups are being taught in parallel, the homogenization of contents and assessment standards is a key requirement. Under the traditional, instructor centred approach, this could be achieved by getting the various instructors to conform to a common script and teaching material, and through common exams; in some cases, each instructor would grade one of the questions for all the groups, thus additionally reducing the potential grading bias. This homogenization is much harder to achieve, however, in a proactive, student centred learning environment, where not stifling the student creativity is of paramount importance.
- Grading accuracy and fairness: for all their drawbacks, including the substantial risk of "measuring accurately the wrong traits", traditional, individual written exams allow a reasonably accurate, fully individualized evaluation. Furthermore, considering the widespread "cheating" culture among Spanish students, written exams provide a tightly control environment where rules can be enforced. On the other hand, home assignments may present higher opportunities for plagiarism, either by copying from Internet or directly from other coursemates. This issue is directly related with the previous ones. The quest for consistency would support common assignments for the various parallel groups. The attempt to contain faculty workload would also support common assignments for the various groups and even reutilizing assignments from previous years. That, however, hinders attempts to detect and control plagiarism, since the instructor grading one student's assignments would not have read the assignments from the students in the other groups or years.

5. School level design approaches.

To illustrate how these challenges are being faced and the design process this involves, this paper will now focus on the abovementioned "Foundations of Engineering Management" (FEM), scheduled to be offered at the UC3M Engineering School starting September 2009.

The ongoing, multi-level iterative design process of the course syllabus and methodology for such a subject involves a multipronged approach, encompassing University- or School-level common methodological design decisions, particularly those affecting the physical infrastructure and the institutional and regulatory framework, and course-level design decisions.

At both levels, pilots have been run in previous years to test requirements and to compare alternative approaches. At the Engineering School level, selected degrees adopted Bologna style learning methodologies before the actual degree conversion took place. At the subject level, partial pilots have been carried out in lower-volume courses in existing degrees.

Among the major University-level common methodological design decisions regarding the new degrees, a few can be highlighted:

- Official regulation of the continuous evaluation. Specific university regulation has been officially approved in Feb 2009 on continuous evaluation. A minimum of 40% of the grade has been allotted to continuous evaluation, with no minimum thresholds being allowed in either the continuous evaluation or the final exam. Attendance to laboratory sessions, however, can be made compulsory. Detailed provisions have been made for the case in which students do not attend the continuous evaluation; their final grade will be 60% of the final exam grade, even if for that particular course continuous evaluation accounts for more than 40%. Students receiving a "fail" grade are entitled to a second, make-up evaluation in the same school year. This "extraordinary" evaluation takes place in June-July, rather than in September as it was previously the case. For this evaluation, each student might choose to retain the continuous evaluation grade obtained during the course and take again the final examination, or to get a final grade of 75% of the final exam grade.
- Groups of varying sizes and scheduling. All subjects in the new degrees encompass 6 ECTS (exceptionally 3 ECTS, or half a regular subject). A standard weekly schedule for 6-ECTS courses has been established, comprising a 90 minutes large-group lecture for up to 120 students and a 90 minutes small-group session, in which each large group is broken up in 3 smaller groups. Evaluation takes place in the small groups. This is aimed at allowing a small group setting where interactive methodologies can be applied, while containing the overall cost impact. 15 minute breaks are scheduled between 90 minute sessions, as compared to the previous practice of 50 minute sessions; these longer sessions were deemed more appropriate for student engagement. This leads to new infrastructure requirements both in terms of the size and number of classrooms required and in terms of the functionality and equipment required in the smaller classrooms, where the participative methodology is supposed to be fully applied.

6. Course level design approaches.

For the Foundations of Engineering Management course, this will result, in term 1, 2009-10, in 6 small groups + 3 large groups in Spanish, in addition to 1 small group + 1 "large" group being taught in English. This will grow in term 2 to 17 small groups + 6 large groups (one of them being taught in Engish). In 2011, when the remaining 3 bachelor degrees reach 4th course, this will grow to about 34 small groups and 15 large groups per year. This figure should grow further as the remaining engineering degrees get converted.

To prepare for this future scenario, in the last few years various elements of the methodology have been gradually introduced in lower-volume courses in existing degrees, and various approaches have been tried and evaluated in terms of their effectiveness and their scalability.

The EHEA-compliant Master in Engineering Management and Logistics has served as an integrated testbed, with all its subjects being taught, in the last three years, basically according to the Bologna approach: approx. 50% of the grade being based on continuous evaluation, compulsory attendance, emphasis shift from lectures and theoretical examinations to individual and group assignments, reduced number of lecture hours per ECTS with workload being concentrated in the student preparation, etc. This has provided valuable insights into the potential learning effectiveness of these approaches, but has also highlighted its difficulties and the risk of the instructor's workload exploding out of control, particularly in terms of grading assignments. Care must also be exercised while extrapolating these experiences to FEM, since Master students have a different profile and their number has been capped at 20.

To get some insights from student groups that are more alike to the FEM profile, partial pilots have also been carried out in various student groups, in existing degrees, in subjects whose content is similar to FEM. Several English-based groups (where the institutional framework is more flexible, since students can always opt out into a Spanish group) have tried compulsory attendance, continuous evaluation and emphasis on homework assignments. In the last three years, four of these courses have been taught by foreign professors coming from institutions that routinely apply Bologna-like methodologies, and the results and the acceptance by the Spanish students has been closely monitored (with mixed results). Two university sponsored pilots (one of them still running) have focused on improving teamwork and communication tools in a problem-based learning environment, making extensive use of interaction tools (such as electronic forums) and migrating to the web platform (Moodle) on which the new degrees are supported.

Furthermore, the actual experience of those departments whose courses are located in the first year, and have therefore already faced these issues this first year is being explored.

While incorporating all these elements into the actual design of the FEM, some detailed but nevertheless relevant additional issues arose. Several of them concerned the coordination of the small groups.

Splitting the large groups into several small groups requires that the course content is consequently divided in the components that can best be taught in a traditional lecture format and those that benefit from the interaction that smaller groups allow. The methodology for the small group sessions must also be defined. A sensible approach would be to use the weekly large group session to explain theoretical contents and use the other small group session to carry out practical exercises, case discussions and other activities that engage students in an active learning mode. A recommended methodology for this is to further split the small group into several working groups of about 5 students, each of which would then discuss and work during the session on a group assignment, while the instructor walks from group to group providing support and guidance. This requires multi-functional classrooms, with movable tables, that allow rearranging the students in working groups.

The actual implementation of this approach, however, is fraught with stumbling blocks. Since each large group is split in 2-3 small groups, it is highly unlikely that the same instructor teaches the large group and all of the small groups. If the small group session applies the concepts taught in the previous large group session, this creates a complex need for detailed coordination between the various instructors. As an example, unevenly distributed festivities might lead to a given small group, scheduled for one day of the week, to miss a session, while as the other groups, scheduled in different days of the week, press ahead. The initial year's experience with the new degrees also suggests that, since evaluation is carried out in the small groups, attendance and attitude in the large groups drop.

A related aspect, particularly acute in a subject that is scheduled to be offered in over 30 groups a year, is the fact that some groups may have different methodology-related resources than other groups. A choice must then be made between uniformly adopting the methodology that requires the minimum level of resources, thus reducing the overall level to that of the common denominator, or to allow and manage differences in methodology between groups. An obvious example based on a physical resource is the availability of multi-functional classrooms. At least for the time being, the UC3M Engineering School can not guarantee availability of multi-functional classrooms (a prerequisite for the multiple working groups approach) for all small groups, thus either different groups follow different methodologies or the multiple working groups approach is forgone for all groups. Even though less clear-cut, this issue is likely to be most important regarding intangible, faculty profile related capabilities. Some faculty members can be reasonably expected to apply certain participative methodologies in a value-adding manner, while as others, if requested to apply them, may do so in a counterproductive way, again leading to the same dilemma of whether to allow heterogeneity in methodology within the same subject.

7. Complementary approaches.

Besides a careful design of the course curriculum and coordination mechanisms that takes these issues into account, several approaches have been identified as helpful for surmounting these challenges, such as:

- Sampling based grading: This is potentially the single most important tool to make this methodology shift viable. It involves grading only a fraction of the assignments or intermediate tests each student has submitted. The obvious advantage is the reduced grading workload, thus allowing more frequent and/or more complex assignments. A significant drawback is the generally negative attitude that students display towards sampling based grading. Extensive utilization of this approach in the pilots provides several hints to minimize rejection among students, such as:
  - Clarify at the beginning of the course that sampling based grading will be used, how, and why is it important to allow a more student centred approach.
  - Grade the same assignments for each student, rather than a few students for each assignment, to allay worries that some students will have harder assignments evaluated.
  - Proactively address the concern that by grading only some assignments students may be exposed to higher unpredictability (the assignment graded may happen to be the one they did worst) by highlighting that the same situation happens in a traditional exam, where only some of the potential questions are asked, and they may happen to be the ones the student does not know.
- Learning Management System support: Proper application of information technology is probably the most significant and promising approach. An obvious element of that is exploiting the administration functionalities of Web based Learning Management Systems (Moodle©, WebCT© ...) to automate assignment collection, identify students that failed to turn in their assignmentes, etc.

- IT mediated grading: This involves a range of options, from semi-automated generation of different versions of basically the same assignments, to the automated generation and grading of multiple choice tests drawing from test question databases (e.g., those provided by many authors through their publisher's web systems). For Spanish based tuition, these approaches often face an additional hurdle due to the scarcity of material (test databases...) in Spanish. Another issue is the compatibility among tools and platforms. For the system to fulfil its potential, test databases from various sources (complemented with ad hoc items) must be integrated into a grading system, which must in turn be integrated in the university's web based Learning Management System. Even though standard intermediate formats have been defined to simplify the passage from tool to tool, that is still currently a cumbersome process.
- Antiplagiarism tools: The use of tools such as Turnitin© might help to deter plagiarism. These tools allow the instructor to submit the student's assignments through Internet to the tool's database, or, rather, to ask the students to submit their assignments directly to the tool's site, where they can be collected by the instructor after being analyzed. The tool would then compare these assignments both to Internet resources and to its own historical database of submitted documents (allowing it to detect, for example, plagiarism among coursemates, even from different groups or years, provided the same tool is used). A report identifying and quantifying eventual plagiarism is then prepared, along with an identification of sources used and whether those sources had been credited in the document. Again this approach faces language issues and usage fees as well as some legal doubts regarding the right to force students to submit their work through these tools. As an illustration, four American students have sued iParadigms, LLC (the company that provides Turnitin) alleging that by storing and utilizing their work they were infringing their copyright. However, the students' case has been dismissed both by the District Judge, and, on April 16, 2009, by the US Court of Appeals.
- Exploitation of synergies between research and education. Actively engaging the students can be facilitated by, on the one hand, involving selected students in actual research projects, and, on the other hand, including as a specific aim in the research projects the production of results that can enrich the educational process. In this specific case, a multi-year research project in which the whole Engineering Management group is involved provides both the setting for allowing particularly competent and motivated students to get an initial exposure to research, and a wealth of real-life problems, models and situations that are being used to develop the material for the practical sessions.
- OpenCourseware utilization. These approaches involve the preparation and renewal of effort-intensive student assignments. This workload can be alleviated by fully exploiting the reutilization opportunities offered by material shared by leading institutions such as the MIT.
- Other approaches are being tested, however no clear conclusion has yet been reached regarding their applicability in this context. As an example, peer review, whereby students evaluate (and hopefully learn from) one another's work offers significant potential for the evaluation of complex, hard-to-automate assignments, and is increasingly supported by tools such as those offered by Turnitin. However, the cultural misfit with the current environment precludes a clear verdict on its applicability.

8. Conclusions

The implementation of the European Higher Education Area (EHEA) in Engineering Education in Spain has two main components. The most tangible, visible or formal component encompasses reorganizing the engineering degrees curricula along the three cycle structure, incorporating elements such as adopting ECTS as the measurement unit or issuing Diploma supplements. These changes can be "imposed by decree" and they will be implemented, for better or worse, in due course. The second, more subtle component involves a methodological and cultural shift towards an active learning, student centric, learning outcomes based approach. The actual implementation of this second component in the near future is far from guaranteed. On the other hand, implementing EHEA's formal aspects without adopting its methodological underpinnings could actually make things worse.

Implementing this methodological and cultural shift is fraught with difficulties in the Spanish engineering education environment, particularly in high volume courses. Careful advanced planning and testing, along with the adoption of facilitating approaches, such as the ones analyzed in this paper, as well as the exploitation of synergies between research and education, can increase the likelihood of a successful transition.

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