A Coordination Protocol for Higher Education Degrees

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Abstract - When a higher education institution creates a new curriculum for a given degree, the design process itself ensures a correct balance and coordination among the subjects in the degree, not only about the contents and learning outcomes of each subject, but also in the learning weight of all the subjects in each semester. However, it is common that, as time goes on, the degree evolves. This evolution may be produced, for example, in order to cope with scientific or technological advances, or simply because teachers may favor the contents, methodologies, assessment techniques, etc., which they know best. The problem is that this evolution is normally carried out in the context of each individual subject, which progressively makes the entire curriculum to lose its initial balance. This paper introduces a coordination protocol designed to regain the balance among the subjects in a degree, while this degree is being taught.

Index Terms - Coordination protocol, Higher education degree, Curriculum design, Teaching collaboration.

INTRODUCTION

Before a higher education degree can be put into practice, a program or curriculum must be designed for it. The design of a degree program takes into account several aspects with the overall goal of giving students the qualification they need to obtain the degree. Such aspects normally include, among others, the expected learning outcomes of the students (in terms of knowledge, skills, competences) and the required teaching and learning effort that students need in order to successfully obtain the qualification. For example, in the computing-related fields, many degrees are designed according to the guidelines of the Computing Curricula project [1], jointly developed by the Institute of Electrical and Electronic Engineers (IEEE) and the Association of Computing Machinery (ACM).

The result of the design phase for a given degree (that is, its curriculum) is basically a list of courses, structured in semesters and/or academic years, with each course described in some detail. The level of detail in the course description depends on the institution that designs the degree, according to aspects such as the institution’s traditions and norms, the country or regional regulations, etc. If the curriculum is well designed, the actual structure of courses ensures two main objectives: on the one hand, courses are correctly sequenced and coordinated (learning outcomes acquired in previous courses prepare students to successfully deal with later courses); on the other hand, the learning effort required by students to pass the courses in each semester/year is balanced, in order to get a reasonable upper limit of working hours.

However, independently of how well designed, any degree is prone to suffer some deviations in the two objectives mentioned above (course coordination and effort balance) after it has been taught for some time. This is because degrees evolve in time. Some times, the evolution is necessary, for example in order to cope with scientific or technological advances; some other times, the evolution is produced because the same course is assigned to different teachers, and each one favors the particular contents, methodologies, assessment techniques, etc., the teacher knows best. In any case, the problem with this evolution is that it is normally produced in the context of each individual subject, which progressively makes the entire curriculum to lose its initial coordination and balance.

This paper presents a coordination protocol designed to regain the balance among the subjects in a degree, while this degree is being taught. The protocol is founded in four major tasks: horizontal coordination of subjects, vertical coordination of subjects, student effort analysis and development of teaching guides. The protocol proposes to have a few teachers specially appointed to guide the process, but it also requires an active participation of all teachers in the degree. If so, all tasks in the protocol can be applied in a single academic year.

The coordination protocol is the result of our experience in the context of an institutional project called PACE (Action Plan for the European Convergence), promoted by the Universidad Politécnica de Valencia (UPV). The final goal of this project is to prepare the members and institutions inside our University to the new European Higher Education Area (EHEA). In particular, the protocol has been developed for the current degrees of the Faculty of Computer Science at the UPV.

THE PACE PROJECT

Over the last few years, the Action Plan for the European Convergence (PACE) project [2] has been the institutional framework promoted by the UPV to involve schools and faculties in teaching innovation. In essence, the PACE project is a general framework which covers all possible actions in order to promote both teaching excellence and the

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T3E-21
so-called European Convergence, that is, the adaptation of the University to the new degrees to be designed in the context of the European Higher Education Area (EHEA).

Some of the actions promoted by the PACE project are directly organized by the University direction. In this context, the University has developed an integrated Virtual Learning Environment (VLE) called PoliformaT [3], which is one of the first educational platforms derived from Sakai [4] in Spain. PoliformaT, which now gives support to a community of 40,000 students and more than 2,000 teachers at the UPV, encompasses all the teaching tools previously available in the UPV as well as some specific tools appropriate for the new EHEA context.

However, the great majority of actions inside the PACE project are delegated to the different centers (schools and faculties) inside the University. In this way, each center defines a particular program of actions to be carried out in each academic year, according to its own situation and the peculiarities of its degrees, teachers, students, etc.

In particular, the Faculty of Computer Science has participated in the following actions over the last years: coordination of subjects, at both horizontal (same year) and vertical (different years) levels, evaluation of the student learning effort in each course, development of a standardized teaching guide for each course, review of the competences of each degree, and support of teaching innovation initiatives in the context of individual courses [5][6]. The coordination protocol presented in the next section is the result of our experience in all these actions.

One important aspect of the PACE project is that the University has appointed some people in each center in order to support and steer the PACE actions inside the center. These people are normally chosen among the members of the center’s direction, as well as among the teachers in the center with experience in teaching innovation projects. Concretely, there are six positions per center: the GEA (Adaptation Manager), who is the responsible of the PACE project in the center, and five COCAs (Course Coordinator), who help the GEA in the different PACE actions to be carried out and, specifically, are responsible of the coordination of courses in the center’s degrees (normally, each COCA coordinates the courses in an academic year).

The existence of this “steering committee” in the center has been essential to obtain the desired results inside the PACE project.

**THE PROTOCOL**

This section introduces a protocol intended to regain coordination and balance in an *active* degree, that is, while this degree is being taught. The protocol proposes a *coordination process* structured in five tasks: (T1) Information Gathering and Scheduling, (T2) Horizontal Coordination, (T3) Vertical Coordination, (T4) Student Effort Analysis, and (T5) Development of Teaching Guides. The idea is to apply the process periodically, for example, every four or five years, depending on the amount of subjects and the coordination complexity of the degree.

Inspired by the PACE project presented above, the coordination protocol proposes to have a *Steering Committee* (SC), which is the responsible for applying the protocol. The committee consists on eight to ten people, depending on the number of academic years and the total number of courses in the degree: the Coordination Manager (CM), a Course Coordinator (CC) for each academic year in the degree, and three to five students, which will have a twofold activity: on the one hand, they will help teachers in each phase of the coordination process (gathering information, writing of the meeting minutes, production of the resulting documents in each task, etc.); on the other hand, these students will incorporate their knowledge and viewpoints about the degree’s courses to the process. For this reason, it is interesting, although not necessary, for them to be in their last year of the degree.

The coordination process has been designed to fit in a single academic year, although meeting the deadlines for the different tasks strongly depends on the active participation of all the people involved in the degree, specially the teachers responsible for the degree’s courses. Figure 1 presents the global schedule of the protocol. Please note that the schedule does not consider the duration of terms or vacation periods, since they may be different in each institution. On the contrary, the schedule considers a continuous period of nine working months in an academic year. For this reason, the schedule has to be instantiated to the particular case of the institution applying the protocol, as explained below. Also, the schedule considers the maximum duration of the protocol, that is, when it is applied for the first time to a given degree. Subsequent applications would probably imply a significant reduction in the duration of some tasks (for example, great part of the information to be collected in task T1 would be already available, while task T5 should only imply minor adjustments of the teaching guides).

![Figure 1: Global Schedule of the Coordination Process.](image)

In the following subsections, each task in the protocol is fully specified in terms of seven aspects: (a) purpose, (b) people involved, (c) input documentation, (d) procedure, (e) results, (f) schedule, and (g) quality indicators.

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T3E-22


I. Information Gathering and Scheduling

The coordination process is mainly based on processing and analyzing information about the degree (curriculum), its courses, and the dedication of students. As this implies many people and large amounts of information, the first task to be accomplished includes both the collection of all the relevant information that is initially available and the detailed scheduling of the entire coordination process. This first task also gives the steering committee opportunity to start working together.

This task is specified as follows:

a) **Purpose:** To gather all the relevant information about the coordination process that is initially available and to schedule the rest of the protocol tasks, including a deadline and a supervisor for each task.

b) **People:** All the members of the SC (CM, CCs and students).

c) **Input information:** The input information includes, at least, the curriculum description, all the available (public) information about the courses in the degree, and any other additional document describing aspects of the degree not included in the curriculum (for example, enrolling incompatibilities between courses, the department/teacher in charge of each course, etc.).

d) **Procedure:** The collection and classification of the documents described above will be shared among the members of the SC. The SC will meet regularly in order to put together the available documents and to write the reports described below. After the classification of documents, the SC will schedule the rest of tasks in the protocol. The schedule should consider not only the expected duration of each task (that should be instantiated for the particular degree under study) but also the duration of terms, the vacation periods, etc.

e) **Results:** The results are three written reports: (1) a classification of both the available documents (including a short description of each one), and the ones that were impossible to find; (2) a table describing, for each course, which description items (contents, methodology, assessment, bibliography, etc.) were available and which were not; and (3) a detailed schedule of the entire coordination process, including the deadline and the person responsible for each task.

f) **Schedule:** 4 weeks.

g) **Quality indicators:** Number of relevant documents detected (found and missing), number of reviewed courses, number of description items per course reviewed, number of meetings of the SC.

II. Horizontal Coordination

Horizontal coordination consists of revising the coordination of contents among courses in the same semester or academic year in the degree, with the general objective of increasing the coherence among these courses. This can be realized in several different types of agreements among courses. For example, the consistent use of the same notation or terminology, the distribution of common contents, the correct sequencing of contents (a concept is explained in one course before it is needed in another course in the same semester), the development of common theory or lab materials, etc.

Horizontal coordination can be performed in a very detailed way, since the number of teachers involved is usually small and so it is possible for them to meet personally in order to discuss what they do in the context of their own courses, detect aspects to improve coordination, and reach the corresponding agreements.

This task is specified as follows:

a) **Purpose:** To improve the coordination/coherence of all the courses in each academic year in the degree.

b) **People:** The CCs and students of the SC and the teachers responsible of the degree’s courses.

c) **Input information:** The documents about the degree and its courses collected in Task T1.

d) **Procedure:** One CC and one student in the SC will be assigned to each academic year in the degree. Then, the CC and the student assigned to a given year will arrange a series of weekly meetings with the teachers in charge of the courses in this year (therefore, the coordination of courses in all years can be done in parallel). Before the first meeting, the public, available information about the degree and the related courses will be sent to the teachers. During the meetings, each teacher will make a detailed presentation about her course, including not only the contents and potential relations with other courses, but also the teaching methodology, assessment strategy, organization, etc. This procedure has a twofold advantage. On the one hand, it increases the general knowledge of how teachers organize their courses, which may be very educational to other teachers. On the other hand, teachers can get to know each other and to discuss about common problems and situations, the way they work with students (normally, the same students), etc. All this, in turn, increases the coordination (and agreement) possibilities.

e) **Results:** The meeting minutes, which should include the presentations of courses in detail, the detection of coordination problems and the subsequent agreements reached by teachers.

f) **Schedule:** 6 to 8 weeks, depending on the number of courses in each academic year.

g) **Quality indicators:** Number of meetings, number of teachers attending the meetings (percentage of the total cited teachers), number of coordination problems detected, number of coordination agreements reached.

III. Vertical Coordination

Vertical coordination of courses is equivalent to the horizontal coordination, but among courses from different academic years. The objective in this case is to ensure that the right learning outcomes are obtained before they are needed in (later courses of) the degree, rather than increasing the coherence among courses. In this sense, vertical coordination...
coordination relations can also be called learning prerequisites.

According to our experience, vertical coordination relations among courses in a degree can be classified in two different types: strong and particular relations. Two or more courses are strongly related when they present a high subject affinity (for example, in our Computer Science degree, the courses “Programming”, “Data Structures and Algorithms” and “Advanced Algorithm Design” are strongly related). Usually, subjects strongly related belong to the same department and their teachers are used to coordinate their contents (more or less) regularly. On the other hand, two courses are particularly related when the previous course offers some specific content (or skill, competence, etc.), which is required by the later course (for example, in our Computer Science degree, the concept of differential equation from the “Math Analysis” course in the first year is a required as a tool in the Poisson Processes chapter of the “Statistics” course in the second year). Particular relations are harder to coordinate than strong ones because in the former case, the courses have apparently less in common and their teachers are usually less in contact with each other. Furthermore, small variations in some contents of the previous course (or simply in the detail level in which these contents are explained) may have a strong negative effect in the later course.

Since vertical coordination involves all teachers in the degree, personal meetings are not the best option to detect problems or to reach agreements. Thus, the protocol proposes the SC to preprocess the potential prerequisites among courses (including strong and particular relations) into a preliminary document, which can then be sent to teachers in order to get their feedback. Once this feedback is received, failing prerequisites can be detected and the corresponding teachers can be put in contact in order to solve them.

This task is specified as follows:

a) **Purpose:** To identify and document all the learning prerequisites among courses in the degree. Since some of them may be missing in the current state of the degree, the task’s goal also includes the detection of this failing relations. Then, the related teachers can be put in contact, so they can agree the changes to be introduced in their courses in order to regain coordination.

b) **People:** The SC and all the teachers in the degree.

c) **Input information:** All the documents collected in Task T1 plus the resulting documents of Task T2.

d) **Procedure:** This task will be carried out in two steps. In the first step, the members of the SC will organize a series of meetings in order to analyze the contents of all the courses in the degree (by using all the information available so far in the process, both collected and generated). The SC has to generate a preliminary document containing all the identified prerequisites among subjects in the degree (strong and particular, existing and missing). Since the potential number of relations is enormous, this document should be as intuitive and graphical as possible, in order to be easily processed by teachers. In the second step, the preliminary document will be sent to teachers, and they will have some time to check it and to send back their feedback to the SC. Feedback can include the confirmation or rejection of detected prerequisites, as well as the proposal of new prerequisites to be present. In any case, feedback regarding a given prerequisite has to be first agreed by all the teachers involved before the SC accepts it to be included in the final document.

e) **Results:** A document containing all the prerequisites among courses in the degree, agreed by all the teachers.

f) **Schedule:** 8 to 12 weeks.

g) **Quality indicators:** Number of vertical relations (prerequisites) detected by the SC, number of teachers with active participation, number of comments made by teachers to the preliminary document, number of missing prerequisites identified, number of agreements among teachers to solve missing prerequisites.

**IV. Student Effort Analysis**

According to the requirements of the Bologna Process, the new degrees in the EHEA have to measure courses in European Credit Transfer System (ECTS) credits, which is a major change for some European countries. Many countries (like Spain, for example) used to measure courses in teaching credits, with each credit being some amount of teaching hours, while ECTS credits measure the student learning effort, including not only attendance to lectures, but also the preparation of reports, personal study, the course’s exam, etc. From the students’ viewpoint, learning credits present a clear advantage, which is that they know in advance how much effort (in average) each course will suppose for them. From the teachers’ viewpoint, however, learning credits present a difficulty, which is the estimation of the actual effort that an “average student” will need to invest in order to get each learning outcome in the course. For example, if a course is worth 5 learning credits, and each credit is worth 30 hours of student work, then the teacher must organize the teaching and learning activities in the course in order to ensure that students can obtain all the learning outcomes in 150 hours at most.

Due to this difficulty, especially in countries without a learning credits tradition, teachers need some feedback on the actual amount of time that students devote to each learning activity in their courses. This task proposes the analysis of this information, which is supposed to have been previously collected (in some previous academic years). For example, the UPV has developed a web-based tool called SAGAD (Automatic System for Learning Activity Management) [7], with which students fill their weekly dedication to each activity in each of their enrolled subjects. At the end of the academic year, the tool generates a full statistic report of each course, which is available to both the center direction and the course’s teachers.

This task is specified as follows:

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a) **Purpose:** To ensure that the dedication of students to each course is reasonable and below the maximum limit established by the course’s learning credits.

b) **People:** The SC and the teachers whose courses present significant deviations in student dedication.

c) **Input information:** Statistics about student dedication in each course in the degree (the collection and processing of this statistical information is outside the scope of the coordination protocol; that is, it is supposed to be available).

d) **Procedure:** This task will be carried out in two steps. In the first step, the members of the SC will organize a series of meetings in order to analyze the student dedication in all the courses in the degree. The purpose of this step is to identify courses that present a significant deviation in the intended student dedication and, specifically, those courses in which the average dedications clearly exceed their assigned credits. In the second step, the CM will personally meet with the teacher in charge of each of these courses, in order to discuss the problem and to propose solutions.

e) **Results:** This task does not generate a specific document.

f) **Schedule:** 6 to 8 weeks.

g) **Quality indicators:** Number of courses revised, number of deviations about student dedication found, number of meetings with teachers.

**V. Development of Teaching Guides**

The coordination protocol presented in this paper adopts some of the terms which have been introduced in the context of the PACE Project (see Section 2). This is the case of the Coordinator Manager, previously introduced, and the **Teaching Guide** (TG). The concept of TG corresponds to the general concept of course description, but with some distinctive aspects: first, a TG is by definition an full-featured description of a course (including contents, prerequisites, learning outcomes, teaching and assessment methodologies, distribution of the student effort, resources, bibliography, detailed schedule of activities, etc.) in a **standardized** format. Second, the TGs must be public for students before course enrollment. And third, the TG acts like a **teaching contract** between the course teacher and the students, in the sense that the teacher has to follow the TG description (this should be regulated by the University). The use of such TGs supposes a great advance in the amount, and reliability, of public information available about the courses in a degree.

This task supposes that the degree’s institution has an approved TG form (or, better still, some computer application to edit the TG’s electronic version). If so, this task consists on explaining the teachers in how to include all the information about their courses top the corresponding TGs. The first time the protocol is applied, teachers will have to fill the entire TG, while in subsequent applications, teachers will only need to make the adjustments derived from the coordination process.

**Session T3E**

This task is specified as follows:

a) **Purpose:** To incorporate all the relevant information of each course in the degree to a standardized TG.

b) **People:** The SC and all the teachers in the degree.

c) **Input information:** For each course, all the relevant information about its organization (including any other previous course description), as well as any related result or agreement reached in the context of previous tasks of the coordination process.

d) **Procedure:** This task will be carried out in three steps. If teachers do not have previous experience with filling the TG, the first step will consist on some explanation sessions to teachers organized by the SC. The second step will be to let teachers some time to fill up their TGs, with the technical support of the SC. The third step will consist on the review of the TGs by the SC members. In the case of TGs incompletely or incorrectly filled, the CM or CCs will meet with the related teachers in order to make the corresponding corrections.

e) **Results:** The Teaching Guides of all courses in the degree.

f) **Schedule:** 6 to 8 weeks.

g) **Quality indicators:** Number of courses with TGs filled (percentage of the total number of courses in the degree), number of items correctly filled in each TG.

**THE PROTOCOL AT THE FACULTY OF COMPUTER SCIENCE**

This section presents the main results in the application of the protocol in the two degrees currently active in the Faculty of Computer Science (FIV) of the UPV: Computer Science, and Information and Documentation. In the case of the Computer Science degree, which is a two-cycle degree (three plus two academic years), the protocol has been planned in two phases: first, the coordination of the first cycle, and then the coordination of the entire degree including the second cycle. This section presents the results of the former phase, since the latter is still being developed in this academic year.

In general, the results obtained so far are really good, both in quantitative and qualitative terms. Quantitatively, the number of courses involved and the amount of teachers actively participating in meetings are significant (see table below). Qualitatively, the protocol has been accepted among teachers and students as an interesting tool to improve the teaching quality in the degrees. Furthermore, the application of the protocol has resulted in some interesting initiatives, such as the development of common teaching activities involving different courses.

Table I below includes the main figures derived from the application of the protocol in the two degrees at the FIV. In the case of the Computer Science degree (first cycle only), the participation of courses and teachers is almost complete, being only excluded some elective courses in the third academic year because of their special contents (they are not significantly related to any other previous course). In the case of the Information and Documentation degree, the low participation of teachers in meetings is due to the fact...
that many teachers in this degree are part-time working at the university, and they have participated in the process mainly by e-mail.

TABLE I
THE COORDINATION PROTOCOL AT THE FIV

<table>
<thead>
<tr>
<th>Quality indicator</th>
<th>Absolute figure</th>
<th>Percentage from total</th>
</tr>
</thead>
<tbody>
<tr>
<td># courses participating</td>
<td>37</td>
<td>95.3%</td>
</tr>
<tr>
<td># responsible teachers participating</td>
<td>37</td>
<td>95.3%</td>
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<tr>
<td># meetings</td>
<td>45</td>
<td>---</td>
</tr>
<tr>
<td># responsible teachers attending meetings</td>
<td>---</td>
<td>94.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality indicator</th>
<th>Absolute figure</th>
<th>Percentage from total</th>
</tr>
</thead>
<tbody>
<tr>
<td># courses participating</td>
<td>25</td>
<td>78%</td>
</tr>
<tr>
<td># responsible teachers participating</td>
<td>25</td>
<td>78%</td>
</tr>
<tr>
<td># meetings</td>
<td>14</td>
<td>---</td>
</tr>
<tr>
<td># responsible teachers attending meetings</td>
<td>---</td>
<td>48.7%</td>
</tr>
</tbody>
</table>

One particular result of the protocol has been the elaboration of a graphic “map” describing the relations among all courses in each degree. This map, result from the horizontal and vertical coordination tasks, includes a global view of the courses’ relations plus a detailed view of each relation, including the particular learning outcomes involved in the relation. The map is intended as a tool to put each course in the context of the entire degree, helping both teachers and students.

It is important to point out that some computer programs developed in the context of the PACE project, such as PoliformaT or SAGAD, have been extremely useful in the application of the protocol. In PoliformaT, each course has a specific site shared between the teacher(s) of the course and the students. This site incorporates all the relevant information about the course, including its Teaching Guide. The information available in the sites of many courses has facilitated the collection of input data in Task T1 of the protocol. In the case of SAGAD, this tool has been used by a significant number of students to fill their weekly dedication to each learning activity in their enrolled courses. From this input data, one of the most important results to be extracted has been the average (in hours) that a student needs to pass a course, including teaching and learning effort. This information is going to be used to advise teachers about how to dimension the activities in which they structure their courses, and then to adjust the corresponding Teaching Guides.

The overall result of the coordination protocol implemented at the FIV is not only good, but also exciting. The main achievement is the excellent acceptance of this action among teachers and students, in the understanding that it is necessary to adjust contents in order to improve teaching quality in a degree. In addition, the results of the protocol are an excellent starting point to the development of new degrees. In fact, along this academic year, some commissions inside the FIV are working to generate the new EHEA-compatible degrees that will substitute the existing ones; and the information about contents, relations and prerequisites derived from the coordination protocol are being extensively used to design the new curricula.

CONCLUSIONS

In order to guarantee teaching quality in higher education, a periodic review of degrees must be carried out. This review must involve every aspect related to teaching organization, including both the design of each individual course and the relations and prerequisites among courses.

This paper has presented a coordination protocol intended to regain the correct balance among the courses in a degree. The protocol proposes a coordination process to be carried out by the teachers and (some) students in the degree, under the supervision of a Steering Committee. The results of the process, which should be applied periodically, must include explicit documents describing the current situation of coordination in the degree (e.g., a graphic map of prerequisites among courses) as well as a detailed Teaching Guide of each course. The paper has also presented how the protocol has been applied to the two active degrees at the Faculty of Computer Science of the UPV, with great acceptance among teachers and students.

As a final conclusion, we believe that the design of new curricula based on learning outcomes and student learning effort, along with the availability of Virtual Learning Environments and the use of Teaching Guides (intended as a teaching contract between teachers and students) are major steps in the successful application of coordination protocols like the one presented in this paper.

REFERENCES


