International Journal of Engineering Education Vol. 34, No. 5, pp. 1467–1478, 2018
Printed in Great Britain

0949-149X/91 $3.00+0.00

Optimization of Faculty Time-Management: Some Practical Ideas*

FERMÍN SÁNCHEZ-CARRACEDO[1], EVA MILLÁN[2]**, JULIA GONZÁLEZ-RODRÍGUEZ[3], JUAN-JOSÉ ESCRIBANO-OTERO[4] and MARÍA-JOSÉ GARCÍA-GARCÍA[5]
[1] Department of Computer Architecture, Universitat Politècnica de Catalunya (UPC-BarcelonaTECH), Spain. E-mail: fermin@ac.upc.edu
[2] Dpto. de Lenguajes y Ciencias de la Computación, University of Málaga, Spain. E-mail: eva@lcc.uma.es
[3] Dpto. de Ingeniería en Sistemas Informáticos y Telemáticos, Universidad de Extremadura, Spain. Email: juliagon@unex.es
[4] Academic Direction, School of Architecture, Engineering and Design, Universidad Europea de Madrid, Spain. E-mail: juanjose.escribano@universidadeuropea.es
[5] Department of Student Experience, Universidad Europea de Madrid, Spain. E-mail: mariajose.garcia@universidadeuropea.es

University teachers should devote time to three tasks: teaching, research and management. Some teachers do not know how to manage their time well so teaching tasks take too much time. In order to conduct research or fulfil their management responsibilities, they are obliged to work more hours than those stipulated in their contracts. Furthermore, they often have the feeling that, despite the long hours devoted to teaching, their students fail to obtain the results desired, and this feeling leads to frustration. Some ideas for helping teachers to optimize their teaching time are presented in this article, so that by improving their quality of teaching the number of hours can be reduced and, at the same time, better results can be achieved by their students.

Keywords: training and assessment of educators; time management; faculty training

1. Introduction

Parkinson's Law [1] states that work expands in order to fill the time required for its completion. In other words, ''not enough time exists for a task to be accomplished'', and this amount of time depends on the available time. It is often said that when we are doing a task we enjoy, time seems to fly by.

University professors are required to dedicate their time to teaching, research and management. Some of them are more motivated by teaching, and devote a great deal of time to these responsibilities. When all this time is added to research and management tasks, they often find themselves working longer hours than those stipulated in their professional contracts. This is liable to produce anxiety, because in spite of the large amount of time spent on teaching, they frequently have the perception that all this effort is not worthy, or even that they are failing to improve their students' academic results. The true cause might be that these teachers do not manage their time well.

The goal of an engineer is to do the best possible job with the available resources (materials and time). In this sense, perfection may be the enemy of a job well done. Engineers usually work on projects with tight budget, calculated according to the time assigned to each task in the project. They are required to complete these tasks as well as possible in the time allotted to them, and this does not always result in perfection. Indeed, there is a popular saying that states that if a certain task requires a time T to be completed with 95% of excellence, the remaining 5% will require at least a further amount of time T. Those university teachers who fail to employ their time well are aware of this, because they devote much effort to fulfilling this last 5% of excellence even though it fails to have a significant impact on their students' results. On the other hand, the principle of Pareto applied to time says that 80% of the results comes from 20% of the efforts and time invested. It seems reasonable to think that a teacher should focus on that 20% effort in time and try to automate the rest.

The European Higher Education Area defines the ECTS credit in terms of the time students devote to a subject: between 25 and 30 hours of personal work, over a period of between 18 and 20 weeks. Nothing is said, however, about how much time a teacher should spend on it. European universities usually regulate the equivalence between student credits and the number of hours teachers devote to teaching in terms of the total number of student credits and the budget corresponding to faculty staff. However, in real practice, teachers decide themselves how much time they really devote to teaching.

University teachers tend to be very methodical in their research. They quantify all the measurements in their experiments and draw conclusions from this quantification. On the contrary, few of them adopt the same procedure when it comes to teaching tasks. In particular, very few of them quantify the time

** Corresponding author.

* Accepted 17 April 2018.

they dedicate to teaching, and those who do so have different reasons. For example, in a study [2] a comparison is made between the time devoted by teachers to teach and students' academic results, with the aim of improving the ratio teaching time vs student's results. While initially this might seem a good idea, the objective in this study could be a perversion of the system, since usually, learning results are not equivalent to academic results. Unfortunately, many of the current assessment methods are entirely result-based; that is, they are aimed at obtaining results rather than genuinely ensuring learning. As in many other cases, what is merely an indicator becomes the goal.

A preliminary version of this work [3] was published in 2010. In this former version, authors set out how quality learning could be achieved by using active methodologies, without a significant increase in the time that teachers dedicated to teaching. The work was based on two fundamental ideas:

- Active methodologies produce better learning results than passive methodologies, and
- In many cases, active methodologies require less dedication from teachers than passive ones, since teachers act as tutors, and are not in the centre of the learning process.

On the basis of these ideas, a series of proposals was set out for reducing and/or optimizing the time spent by teachers, without loss of teaching quality. Chickering and Gamson [4] define the following seven principles for good practice in undergraduate education:

- P1: Encouraging contact between students and faculty.
- P2: Developing reciprocity and cooperation among students.
- P3: Encouraging active learning.
- P4: Giving prompt feedback.
- P5: Emphasizing time on task[1].
- P6: Communicating high expectations.
- P7: Respecting diverse talents and ways of learning.

These seven principles should be applied to the different actions adopted by lecturers while teaching: actions during preparation for the subject, actions during teaching of the subject, actions during learning assessment, and transverse actions.

The goal of this paper is to present a set of proposals to help lecturers to increase the quality of their teaching by using the available resources more efficiently; in this case, we focus on *time* as a resource. A detailed description of each proposal is out of the scope of the paper, but references are provided so interested readers can look for further information on how to use and apply them.

The rest of the paper is organized as follows: Section 2 presents the actions to be undertaken during preparation for the subject; Section 3 contains the actions during the teaching of the subject; Section 4 the actions during learning assessment, and Section 5 the transversal actions. Actions corresponding to universities and schools to help teachers to manage their time better are presented in Section 6, and some results of this work can be found in Section 7. Finally, Section 8 concludes the paper.

2. Actions during the preparation for the subject

In this section, we present some actions that lecturers can take during the preparation for subjects in order to optimize their teaching time. Both in this section and in those that follow, we will also present between brackets the principles of teaching quality to which these actions contribute.

2.1 Drawing up graphic presentations for the classroom

It is important to draw up graphic presentations that may serve as a guide in class. These presentations reduce preparation time for the classes (P5), reduce possible errors by teachers and misunderstandings by students, and enable teachers to devote more time to interaction with students (P1) if challenges and questions are included in presentations to communicate high expectations to students (P6).

It is advisable to make the presentations available beforehand, either in Learning Management Systems (LMS), reprography service or in free content publication systems (e.g., Slideshare) [5]. In this way, students can dedicate more time to "being active in class" and less to "copying from the blackboard" (P3). For subjects that are taught to different groups of students, presentations can facilitate group coordination and homogeneity (all groups are provided with the same material). For subjects with various teachers, they facilitate coordination among teachers (P5) and enable work to be distributed more evenly (P5) if teachers share the task of creating them.

Presentations may be drawn up using slide editing programs such as PowerPoint ©, OpenOffice and LibreOffice, and also with online services such as Prezi [6]. However, slides are not the only means for preparing a presentation. Mental and conceptual maps [7–9] are also tools for organizing and representing knowledge, and are very suitable for helping students to relate the concepts addressed in the

[1] In our view, this principle applies both for teachers and students.

course. There is software that allows creating and editing such maps in a very simple way. In the case of mental maps, Freemind [10] can be used as a desktop program and Mindmeister [11] as a web application (allowing also exporting to a Freemind format). ExamTime [12] (currently GoConqr) is a Personal Learning Environment (PLE) which offers a powerful tool for the creation and reutilization of mental maps. Finally, the Cmap [13] desktop application enables conceptual maps to be drawn up.

In addition, explanatory videos may be designed for using in class or out of class. They can address theoretical concepts, problem-solving or lab work. Video production is nowadays available for teachers (with reasonable cost and effort), by means of the use of freeware tools [14]. Animoto [15], Screencast [16] and VideoScribe [17] are three popular tools for making videos. Animoto is a web site where it is possible to make videos from slides, pictures and movies. Screencast allows screen capture with audio and the inclusion of arrows and elements to highlight areas of the image. VideoScribe presents a hand drawing, while a voice on off is heard in the background. A digital pen such as Smartpen [18], which enables simple recording of sound and image, can also be used to record videos similar to those recorded with VideoScribe. These videos can have a significant impact on student learning, since they can be viewed as many times as necessary or stopped and re-run at the speed required for effective learning [19].

2.2 Two versions of the learning guide for the subject

The learning guide for the subject is an indispensable tool for both teachers and students. However, teachers and students are probably looking for different information when they consult the learning guide, and thus our recommendation is having two guides: one for teachers and another one for students. The guide for students can be considered as a subset of the teachers' guide.

The guide for teachers provides a detailed description of the subject and the organization of teaching, which enables coordination time among teachers to be reduced (P5). A well-developed guide could save a great deal of time on meetings, and facilitates the incorporation of new teachers into the subject (P5). The guide for students contains a general description of the subject, and should be confined to the aspects students need most: a clear description of the objectives and contents, of the activities to be carried out by the students to learn them, and of the methods and instruments to be used in the assessment. An appropriate format and synchronization of both guides reduces the time required for updating (P5).

2.3 Updating of material, objectives and contents

Some subjects, especially those of final courses in some disciplines, should be frequently updated, which often requires significant dedication from teachers. Collaborative activities may also be designed, and in these activities, students can help develop part of the material to be used in subsequent courses (P1, P2, P3, P6). This work can be used as class material (e.g., collections of problems or lab practices). During the development of such material, work on professional competencies (P2, P3, P6) can be conducted, such as oral and written communication, information literacy or autonomous learning.

It is advisable to have a "cloud" space where updated information may be stored, and to which all teachers can have access. This space may be a BSCW [20], a wiki, a blog, Google Drive [21], Dropbox [22], etc.

3. Actions during teaching of the subject

This section presents some actions that lecturers can undertake during the teaching of the subject in order to optimize their time.

3.1 Using graphic presentations (P1, P2, P3, P5)

The use of the graphic presentations proposed in Section 2 implies less use of the traditional blackboard, but this does not mean that it should not be used. These presentations reduce the time that teachers need to prepare the class, but as teachers can lecture more quickly, there is the risk that some students will not follow the lesson. To account for this risk, the time devoted in class to each objective of the subject should not be reduced. Students need the same amount of time to assimilate ideas, irrespective of the way in which they are presented. Experienced professionals recommend between 10 to 20 slides per hour, depending on how "full" the slides may be. The time saved by a graphic presentation in comparison with writing on the blackboard can be used to concentrate on active learning. For example, students could be asked to solve problems at home and discuss their resolution in classroom groups (P1–P7), as detailed in [23]. Teachers can thereby dedicate their time to the learning process rather than simply teaching, as well as acting as a consultant and moderator. For some of these problems (especially the more complex) the solution can be presented with a graphic presentation to help students understand.

3.2 Using active learning methodologies (P1, P2, P3, P4, P7)

Active learning methodologies foster creativity in

students [24], placing creativity at the heart of the teaching-learning process. Their objective is to achieve learning through doing. Teachers then energize the classes, although this is not the main aim [25] (P1, P3, P4). Such an approach enables teachers to optimize the time spent on teaching, since their most important task is carried out in the presence of the students. Active learning methodologies may contribute to optimizing the dedication time of teachers. Some of the most well-known active methodologies are outlined below, together with a list of the principles they promote.

- If a topic can be divided into disjunctive parts, the *Jigsaw technique* may be employed [26] (P1– P4, P7).
- If a topic can be addressed using *Case-Based Learning* [27], students can be asked to resolve the case individually (P3), and thereby build knowledge (from the particular to the general) in a collaborative way (P1–P3, P7).
- In a wide range of subjects, student motivation can be greatly improved using *PBL*. The initials PBL are used to refer to both Project Based Learning and Problem Based Learning. Project Based Learning consists of integrating theory with hands-on design projects [28]. Problem Based Learning is a technique in which students work on a preferably real-world problem in groups and have the opportunity to practice teamwork and oral and written communication skills [29]. Problem Based Learning has been implemented in different ways [30]. PBL requires faculty to shift their role from a traditional lecture or consulting role to a coaching role [31]. The Essential Project Design Elements Checklist [32] can be used for a quick evaluation of a project's design, to check whether it includes all the essential elements of PBL or not. This methodology can be employed at any level of studies and with any subject. In [33], for example, it is used in the first year of a Physics course. PBL can contribute to all of the seven principles for good practice (P1–P3, P6, P7).
- *Flipped classroom* [34] is a term coined by Jonathan Bergmann and Aaron Sams, two chemistry teachers at Woodland Park High School in Woodland Park, Colorado. It is a methodology in which students previously prepare (outside the classroom) the topics to be addressed in class, using previously available materials (videos, texts, books, etc.). Class work consists then in sharing information with other classmates and participating in activities for consolidating learning. Flipped Classroom fosters student collaboration (P2), encourages active learning (P3) and strengthens motivation.
- *Gamification* consists in using the so-called "serious games" as a learning method in the classroom. The learning experience is developed around an activity in which students learn by playing [35]. Gamification is closely related to simulation and roleplay techniques, which enable students to learn by immersing themselves in the simulation of a situation that obliges them to adopt one or several different roles [36, 37] (P2, P3).

When students become familiarized with using active methodologies, more time is generated in the classroom than with the use of traditional explanatory methods. This time can be used to correct other tasks and activities (P1, P4) or to start planning for the next class.

Active methodologies enable the professional competencies to be developed in a natural way, while simultaneously addressing the specific competencies of the Degree. It is important to employ different methodologies in order to accommodate the different learning styles (P7) [38].

3.3 Attendance checks and evaluation of activities

Authors do not advocate systematic attendance checks, and believe that it is more recommendable to evaluate classroom tasks and activities rather than attendance (P3, P7). An LMS can be used in this regard (P5), thus obviating the need for teachers to devote time to it. Some activities can be corrected automatically (P4, P5) using tools that are available in many LMSs. If teachers decide to correct the activities personally, it is not strictly necessary to correct them all. A representative sample will help teachers know whether students have acquired the contents and skills, but in in this case, it is advisable to at least provide a correct solution so that all students quickly receive feedback on the result of their work (P4, P5). Self-assessment and peer assessment can also be used (P3-P5) to correct the activities [39].

4. Actions during learning assessment

When learners study without a defined purpose or strategy and do not make an effort to relate new knowledge with previous one, they can only achieve superficial learning. This frequently happens when they strategically study just to pass an exam, and memorize facts and methods to solve problems without trying to understand and connect to previous knowledge. The immediate consequence is that they find every new idea difficult. On the contrary, students perform in-depth learning when they are able to connect together new ideas with previous knowledge and experience, by looking for patterns, underlying theories and evidence in order

to arrive at a conclusion. Superficial learning is quickly forgotten, while in-depth learning remains in the memory [40].

Assessment is closely related to principle P4: Giving prompt feedback. Assessment takes up a great deal of teachers' time, and thus it is necessary to plan the assessment in terms of the available time. Teachers should design the subjects in terms of the assessment they wish or are able to carry out.

Furthermore, assessment highly affects learning, since frequently students only study the contents or skills that are going to be assessed. For this reason, assessment should be diverse and continuous. It is important not to confuse continuous assessment with continuous examination, because this causes students a great amount of stress [41]. Normally, we do not train students to take exams, but this is the way in which we evaluate them. Many instruments of assessment exist that go far beyond examinations [42].

It is also necessary to differentiate diagnosis from assessment. Diagnosis consists in gathering data in order to arrive at a judgement and does not imply assigning grades of any type. It is better to diagnose the performance of the learning groups (P5) than to do so individually, and the ideal way is to conduct assessment several times throughout the course. Assessment, on the other hand, is to judge the value of something on the basis of the data gathered. One may diagnose without assessing, but one cannot assess without having diagnosed before.

Two types of assessment exist: summative assessment and formative assessment. Summative assessment determines the grade that accredits the level of learning attained by the student, and requires decisive intervention by the teacher (grading). Most teachers think only of this type of assessment when designing the assessment for their subject, despite the fact that correction is a repetitive and unwelcome task that occupies a great deal of time (P5). On the other hand, formative assessment guides and improves the teaching-learning process [43, 44]. Self-assessment and peer-assessment are very useful tools in formative assessment (P5). These techniques motivate students and provide them with rapid feedback on learning, almost without the need for intervention by teachers [45]. One way of self-assessment is, for example, when students monitor their learning using a portfolio [46]. The portfolio is a very well-known technique in other disciplines, although its use is relatively recent in engineering studies [47].

Assessment may be structured in four stages: (1) Planning and drawing up of exams; (2) completing the exams; (3) correction of exams, and (4) providing students with feedback. The following sections are focused on each of these stages.

4.1 Planning and drawing up exams

As stated before, the preparation of a learning guide helps in the planning and assessment of the subject. In a similar fashion, and with respect to the development of problem statements for exams, it is preferable to do them collaboratively. To that end, a preliminary (brief) meeting may be held to define the objectives and the weight of each question. Each teacher should write a problem statement (with answer) and solve-check (without having the solution) a question proposed by another teacher. It is important to measure the time taken to solve each question. Taking into account the remarks made by all the teachers, a definitive statement is then drawn up, which ideally should be solved again by one or two teachers. These teachers should not take more than between 1/2 and 1/3 of the time students will have to perform the same operation. Extra questions can be prepared with this method and then saved for future semesters in question banks.

In the same subject, three different types of evaluation can be performed: diagnostic, formative and summative. Diagnostic assessment occurs before instruction and help teachers know whether the students are prepared for the new knowledge or not. Formative assessment is used during teaching to evaluate whether students are learning or not and provide feedback if necessary. Finally, summative learning occurs after instruction, and in many cases the purpose is to grade students.

Regarding diagnosis, it is advisable to conduct an evaluation of the state of student learning at the outset of the course (P3–P5, P7). Thanks to this diagnosis, students are aware of what they know and what they do not know (P4), and they can be asked to go over the material they have studied in previous courses (P3, P7). Teachers can provide revision material without the need to work on it in class (summaries, diagrams, conceptual maps, etc.). This material only has to be prepared once and, once it has been drawn up for the course, it obviates the need to return to topics studied in previous subjects (P5). In addition, it provides continuity for the topics in the subject. Students realize thereby that subjects are not islands unto themselves: they are able to benefit from the material studied in previous subjects and are aware that the knowledge thus gained is helpful in future subjects.

Both diagnosis and formative assessment (P3–P5, P7) require little or no intervention by teachers (feedback), and it is only necessary to prepare the questions once, since they have no bearing on students' results and can be repeated each year with few or even no changes. On the contrary, summative assessment requires intervention by teachers. However, exams can be performed by students outside of the classroom [48].

With respect to summative evaluation, question banks can be used for each topic or objective, as remarked in the beginning of this section. These questions may include the answer or a guide for correction, as well as log of the dates when they have already been used. They are generated progressively and can be used year after year. Students may contribute to the generation of these questions, as remarked in Section 2.3 (P2, P3).

4.2 Grading exams

The use of rubrics facilitates grading (P2–P4) [49]. Rubrics can be found all over the Internet [50]. These rubrics can easily be modified to adapt them to the objectives of the subject. Indeed, students themselves can adapt them [51]. The different types of assessment require different types of rubrics [52]. In general, students' rubrics should be much more precise, since teachers possess better criteria for decision-making in the cases not described in the rubrics, while students lack experience. Nevertheless, it is very difficult to find a rubric that covers all the possible cases, and it is therefore preferable to concentrate on defining the most general cases with precision.

As far as labs are concerned, the use of copy detection tools is recommended wherever possible (P5). A timely correction (subjective, with feedback) in each session prevents the generation of deliverables that require subsequent correction (P1, P3–P7), thereby reducing teacher workload, but obtaining results that have a close correlation with the final grade for the subject [53].

Many LMSs include tools for the generation and automatic correction of multiple-choice tests (P1–P5), with which the questions and answers can be changed in order to personalize the exams for each student.

Student response tools are also useful. They use clickers or mobile devices as an interface [54]. These systems are extremely appropriate for conducting diagnoses and formative assessment, since they contribute to improving student motivation for thinking and replying [55]. They can also be used very effectively for the automatic on-the-spot correction of exams in the lecture hall (P1–P5). Many platforms exist nowadays that provide this type of service. Some are free access, some require payment, while others still are of a mixed type. Some of those [56] with the best performance are Infuse Learning, Quiz Socket, Kahoot, Verso, Socrative, Poll Everywhere and Mentimeter. Most of these systems offer a free version with limited functionality.

4.3 Feedback to students (P1, P3, P4, P5)

Students need constant feedback on the evolution of their learning. If this feedback is badly planned, it may occupy a great deal of teachers' time. Digital publication of solutions and results reduces teacher workload (P4, P5). It is advisable to have appropriate publication formats. It is also convenient to have an efficient grading system to incorporate the grades to student's records (cuts down time spent sending notes).

With regard to the review of examinations (P1, P3–P5), this can be done in groups but with personal attention given to individuals. This technique helps students to understand the mistakes they have made in the exams rather than spending time arguing over the grading system. The fact that other students are present during the review helps to do this successfully. The method consists in providing students with their corrected exams together with their answers and correction criteria so they can compare them and analyse their faults. It is important for students to have all the time they need for this process and to be able to take notes. Checking over the exams can be done in groups of ten students or even larger, since this greatly reduces the time teachers spend reviewing the results of the exams.

5. Transverse actions

Two types of transverse actions are described in this section; those aimed at carrying out and/or improving the coordination of subjects, and those regarding tutorials for the students.

5.1 Coordination actions

Three basic types of coordination exist [57]:

- Subject coordination, in order to prevent repetition of work and to ensure uniformity between groups. In general, a teacher acts as the coordinator for the subject. The time spent on coordination can be significantly reduced with good organization. The organization implies the prior and precise planning of all the tasks that will be carried out during the course, and the planning of the activities the students will do inside and outside the classroom each week of the course. It also involves the development of the material that teachers and students will use during the course.
- Semester coordination (horizontal coordination), the objectives of which are: to provide consistency in objectives and contents, to prevent overlapping, to program joint activities, to draw up a student schedule/agenda, and to plan assessment. The horizontal coordinator of the course and the coordinators of the course subject participate in this process.
- Coordination of the degree, whose main goal is to distribute and monitor the correct distribution of competencies and skills (technical and profes-

sional) between the different subjects, prevent unnecessary overlapping and undertake actions for the guidance and monitoring of students.

In order to ensure that coordination works well, and to prevent overload for teachers with unnecessary meetings (P5), it is vital to have a good organization. In the case of subjects, this organization is achieved by means of an appropriate definition of the learning guide. In the semester and degree coordination, the School should clearly define the mechanisms for swiftly addressing any possible changes in the subjects that may affect other closely related subjects [58]. Coordination involves an initial increase in the workload, but also a saving of time in the mid— and long-term (P5). It also enables consensual decision-making and division (sharing) of labour (P5). Time spent by teachers on coordination can be reduced by using virtual spaces such as forums, chats and so on [59, 60], which also reduces the number of *in situ* meetings as well as eliminating the need for synchronous meetings.

5.2 Actions concerning academic tutorials

In order to cut down on the time teachers spend on academic tutorials, the more advanced students (supervised by their teachers) can act as mentors for their less-experienced colleagues (P1, P2) [61]. For example, [62] describes how final-year module students tutored a PBL experience for first and second year students. The school can help teachers by encouraging this type of initiative.

A very common complaint among teachers is that students do not fully benefit of the time devoted to academic tutorials (consultations). In order to take maximum advantage from this time, occasional activities can be planned with students outside of the classroom (P1, P4). These supervised activities can be assessed, as for example: presentations on the evolution of lab practices; resolution of short exercises; discussions about different alternative solutions to problems, etc. Such activities should be conducted in coordination with the other teachers of the subject. It may seem at first glance that undertaking activities of this nature might increase teacher workload even more, which raises the following question: How can the time devoted to these activities be reduced without losing their effectiveness?

First, it is necessary to take into account that preparation for these activities only has to be done once (P5), since they can be employed again with only a few changes in future courses (P5). Technological resources can also be used to manage these activities and thus reduce the amount of time they require from teachers (P2, P5) such as, for example, discussion forums for theoretical aspects, discussion forum for problem solving, etc. In such forums the main role is performed by students, who express and discuss their doubts (P1, P2, P4, P5, P7). The teacher supervises the forum and intervenes only when necessary (for example, to indicate the correct answer or to solve doubts if no student is able to do so correctly). All the students read the answers, so there is no need to repeat an answer to the same doubt or question several times. Many questions (and answers) can be used again in subsequent courses, which contributes to an improvement in learning without requiring additional effort from teachers. This forum is generally used as a lecture hall in distance-learning universities where LMSs are available. A forum may be set for all the students of subject (teachers could share the work) or one for each group.

In the forum for problem solving, [63] (P1–P7), the teachers might regularly set the resolution to some problem (every week or every fortnight) so the students can discuss the possible solutions. These sessions normally end up becoming a forum of doubts about the subject. Not all the students participate actively, but those who do so achieve a great benefit. Teachers are not obliged to answer the same questions several times over, and the list of problems can be used again in the following course. A set of solutions, with and without mistakes, is obtained in a short time and can be used in other activities.

6. Actions corresponding to universities and schools

Many teachers do not know how to manage well the time they dedicate to teaching. This paper provides a description of some ideas, techniques and methodologies that may help them to improve this management of time, but the schools and universities where they give their classes can also contribute to optimizing the time spent teaching by adopting strategies to improve also the quality of learning.

For example, educational institutions could make specific room in their academic schedules for time devoted to activities of subject assessment [64], so that it does not have to be done during class time. If they were to set aside a slot from 12.00 pm to 3.00 pm every Monday and Wednesday, for instance, students could study at the weekends and not miss class in other subjects (the setting of exams in other subjects is the main reason for non-attendance of students who otherwise attend classes regularly [65]). Assessment of morning and afternoon groups could be conducted jointly. This would enable the number of different problem statements in the subjects involving many groups to be reduced, and thus achieve a more equitable evaluation.

Furthermore, the fact that each teacher would have fewer different problems to correct would simplify this process. Such a time could be used to hold meetings on the subjects or on other issues on days when no assessment activities are foreseen (P5). The execution of this proposal would generate 30 such slots over a 15-week course, during which 30 possible assessment activities could be held. If students study five subjects simultaneously, there would be time for six ''centralized'' activities for each subject during the course. The design of subjects with three centralized activities would therefore enable the activities of two consecutive courses to be coordinated, including subjects with a burden of one exam per week. Moreover, week 16 could also be used, or even subsequent weeks, in order to relieve congestion during the last weeks of the course, which are traditionally loaded with exams.

A further measure that could be adopted is to impart classes to all the subgroups in a group on the same day. This would prevent breakdown of group coordination when a class is missed due to a bank holiday, since this affects all the subgroups equally, and would therefore facilitate intra-subject coordination (P5).

It is also advisable not to organize teaching in theory or problem-solving classes, that is, it is better to use the same group of students for the two types of class. This facilitates the homogeneous distribution of personal work for students [66] as well as the design of the subject. This type of organization is less rigid and enables problem-solving to be tackled when considered convenient and not only during classes marked for that purpose.

With regard to the size of the groups, not dividing the group for problem solving classes reduces the total cost of the subject (in terms of face-to-face classes with teachers), and leads to average-sized groups for active learning sessions. For lab activities, however, in general it is necessary to have smaller student groups. The time saved by not dividing the group for problem-solving lessons could be used for making smaller lab groups, which could in turn facilitate the *in situ* subjective assessment described in Section 4, and makes easier the contact between students and faculty (P1). As previously explained, this would likewise reduce the time required for the management and correction of lab deliverables (P5).

Schools, and universities where appropriate, should provide classrooms and lecture halls with movable tables and chairs, which can be re-arranged for team work. This facilitates active learning (P3) as well as monitoring by teachers (P3, P5). Students could also be encouraged to use their own laptops, tablets or cell phones in class by providing them with plugs and Wi-Fi in each classroom.

Some classrooms could also be provided with audio and video recording equipment for some lectures, which could be recorded thus avoid having to repeat them (P5). Students could then see them as many times as necessary, and at a speed appropriate for their own understanding assimilation (P3, P7). This would also help teachers to focus more on interaction with students (P1). Some classrooms and lecture halls could also be equipped with interactive digital screens that ''automatically'' reflect what is written by teachers (P5). They also allow reusing the solutions to exercises, from one group to another and from one year to the next (P5).

It is a good idea for schools to provide support personnel for teaching (P2–P5). This could be done by means of grants for final year or doctorate students, who could give their support for lab classes, consultations and tutorials.

The Final Year Project is another area where schools can help teachers to optimize their time. Teachers often find that they are obliged to train students who undertake these projects almost from scratch. Schools can assist them by providing students with basic training in project development (P5), offered (or even compulsory) to all students that are about to begin their Final Year Project [67, 68]. This basic training should include the appropriate documentation for students.

In addition, schools should provide support for coordination (subjects, courses, qualification) through recognition of the time devoted to coordination tasks. Schools can also help teachers by organizing the work commissions required for arranging meeting, and by providing specific information that is appropriate for teachers' needs (P5). This information enables teachers to reduce their training time (as opposed to self-training).

LMSs are very important and useful tools. Schools should ensure that students be included automatically in the LMS once they enrol in the course. This would facilitate teachers' tasks and contribute to optimizing their time (P5). Subjects could be uploaded from one course to the next, which would make all the design and reuse of subject material available to various groups for several years. LMSs cuts down on bureaucracy and the need to deliver problems, lab, and practices by hand (P5), as well as enabling the completion and automatic correction of multiple-choice tests (P4, P5). It also facilitates coordination (P1, P2) between teachers themselves and between teachers and students. LMSs discussion forums (P1–P4, P6, P7) facilitate student-to-student and teacher-to-student communication as well as group work tasks (theoretical and problem forums, as described in Section 5, and tutorials (doubt resolution, communication with students and mentoring). The online schedule

for the subject (P5) has a subscription option for the automatic reception of announcements and notifications. Finally, an "official" diary may be kept of the work covered every day or every week in class (P4, P7). This would enable students who have missed classes to follow the course and at the same time serve as "minutes": dates of the next exam or for submissions, material to be assessed and so on. However, other factors are involved. The correct management of all the tools provided by a LMS requires trained teachers and involves dependence on ICT.

7. Results

Table 1 summarizes most of the proposals made in this paper and, when appropriate, the relationship of such proposals with the Chickering and Gamson

Table 1. Summary of proposals and their relationship with Chickering and Gamson seven principles of good practice in undergraduate education

Moment	Action	Proposals	P1	P2	P3	P4	P5	P6	P7
During the preparation of the subject	Presentations	Slides: Power point, OpenOffice, LibreOffice, Prezzi	X		X		X	X	
		Mental and Conceptual Maps: Mindmeister, Freemind, GoConqr, Cmap	X		X		X	X	
		Educational videos: Animoto, Screencast, VideoScribe, Smartpen	X		X		X	X	
	Learning guides	One for teachers, one for students					X		
	Updating materials	Using cloud services both for development and updating: BSCW, wiki, blog, Google Drive, Dropbox							
		Student participation	X	X	X			X	
During teaching	Using presentations	Using time saved on discussions, problem-solving, etc...	X	X	X		X	X	
	Active learning	Jigsaw technique	X	X	X	X			X
		Case-based learning	X	X	X				X
		Project/Problem-based learning	X	X	X			X	X
		Flipped teaching		X	X				
		Gamification		X	X				
	Attendance checks	Evaluate activities and tasks instead of attendance			X				X
		Automatic correction				X	X		
		Provide correct solutions for tasks				X	X		
		Self-assessment and peer evaluation			X	X	X		
During learning assessment	Planning exams	Collaborative exam posing.							
	Completion of exams	Diagnosis and formative assessment			X	X	X		X
		Development of question banks (students might help)		X	X				
	Correction of exams	Use of rubrics		X	X	X			
		Use of copy detection tools					X		
		Automatic posing and correction of multiple choice tests	X	X	X	X	X		
		Use of student response tools	X	X	X	X	X		
	Feedback to students	Digital publication of solutions, results and comments	X		X	X	X	X	X
		Review of the examinations in groups (individual attention)	X		X	X	X		
Transversal	Coordination	Intra-subject: learning guides					X		
		Intra-course and inter-course: virtual spaces, discussion forum, problem-solving forum					X	X	
	Academic tutorials	Students as mentors	X	X					
		Planning of activities outside the classroom	X			X			
Actions corresponding to universities and schools	Subject organization and resources	Making room in the schedule for subject assessment sessions					X		
		Organizing groups for each subject in an appropriate way	X		X		X		
		Appropriate equipment of classrooms	X		X		X		X
	Teachers support	Providing support personnel for teaching		X	X	X	X		
		Providing common training in project management for students					X		
		Recognition of time devoted to coordination tasks					X		
		Giving support to teachers by means of LMSs	X	X	X	X	X	X	X

seven principles of good practice in undergraduate education.

Regarding practical applications, the work presented in this article has led to a 5-hour workshop given by the first author at different universities over the last eight years. The workshop is aimed at teachers who are dissatisfied with the management of their time. These teachers feel that they devote too much time to teaching tasks and would like to know about techniques to enable their students to obtain the same—or better—learning results, but in a way that involves a reduction in teacher's time. The teachers who attend the workshop dedicate, in general, quite a lot more than 40 hours per week to teaching, which leads to a feeling of dissatisfaction because, apart from failing to achieve the results they expected, they feel that they often neglect other facets of their work or even their personal and family relations. Around 20 teachers usually attend each session of the workshop, although on some occasion attendance has risen to 40. The workshop is, from 2015, a subject of the UPC-BarcelonaTECH Degree ''University Education in Science, Technology, Engineering and Mathematics (STEM)''.

In 2010, the workshop was held at the UPC-BarcelonaTECH (Spain), the Universidad de Málaga (Spain) and the Universidad de Sevilla (Spain); in 2011, it was held at the Universidad de Murcia (Spain), the Universidad de Sevilla (Spain) and the UPC-BarcelonaTECH (Spain); in 2012, 2014 and 2015, it was held at the UPC-BarcelonaTECH (Spain); in 2016 at the UPC-BarcelonaTECH (Spain), the Universidad de Almería (Spain) and the Universidad de Guadalajara (Mexico); and in 2017 at the UPC-BarcelonaTECH (Spain) and the Universidad de Almería (Spain). More than 300 teachers have attended the workshop and the training they have received there has been rated very positively. It is impossible to synthesize easily this rating, since each university uses its own surveys and metrics but, in all cases, teachers have stated that the training they have received at the workshop has helped them to optimize the time they devote to teaching tasks.

8. Conclusions

In this paper, some ideas for helping university teachers to manage the time they spend teaching better are presented. These ideas are classified according to the types of actions undertaken by teachers in the execution of their teaching tasks: during preparation of the subject, the teaching of the subject and the assessment of the subject, as well as actions of a transversal nature.

For each action, a description is given of a set of ideas, techniques, methodologies and tools to assist teachers in the optimization of the time they devote to teaching. Many of these proposals are aimed at the reuse of material from one course to the next. The use of the appropriate tools in each case is essential for students to obtain better learning results. This is achieved by taking into account the seven principles of good practice in undergraduate education in all the actions.

Schools and universities can also do much to facilitate teachers' tasks: (1) making room in the schedule for subject assessment sessions; (2) organizing groups for each subject in a manner that saves coordination time and facilitates the use of active learning strategies; (3) appropriate equipment of classrooms to enable students to work in teams with their laptops, tablets and cell phones, and teachers to record and reproduce classes easily; (4) providing support personnel for teaching; (5) providing common training in project management for students who do the Final Year Project; (6) recognition of time devoted to coordination tasks; and (7) giving support to teachers by means of LMSs.

This paper has not considered other issues regarding lecturer's skills and experience, for example her/his expertise on the subject matter, knowledge about pedagogical models and educational IT tool, expertise, etc. All these issues do have big influence in the time spent in teaching, and are therefore of high importance, but they depend on many factors and evolve with time. For example, a teacher could spend many hours the first time that he/she uses a video tool, but this time will decrease significantly with practice.

Acknowledgements—Authors would like to thank Joe Miró (UIB) for his help and contribution for the work presented in this paper. Author Fermín Sánchez Carracedo has been partially supported by his institution, Universitat Politècnica de Catalunya—BarcelonaTech. Author Eva Millán has been partially supported by her institution, Universidad de Málaga. Author Julia González has been partially supported by her institution, Universidad de Extremadura. Authors Juan José Escribano and Marçia José García have been partially supported by their institution, Universidad Europea de Madrid.

References

1. C. N. Parkinson, *Parkinson's Law or The Pursuit of Progress*, Penguin Books, Middlesex, 1965.
2. M. J. Blesa, A. Duch, J. Gabarro, J. Petit and M. Serna, Análisis de la evolución de un curso: productividad y desigualdad, *Proceedings of the XXII Jornadas de Enseñanza Universitaria sobre Informática*, *JENUI 2016*, Almería, Spain, pp. 153–160.
3. F. Sánchez Carracedo, J. J. Escribano, M. J. García, J. González and E. Millán, Ideas para reducir el trabajo del prof-EEES-or, *Proceedings of the XVI Jornadas de Enseñanza Universitaria sobre Informática, JENUI 2010*, Santiago de Compostela, Spain, pp. 301–308.
4. A. W. Chickering and Z. F. Gamson. Seven principles for good practice in undergraduate education. *The Wingspread Journal*, **9**(2), 1987, pp. 1–15.

5. Slideshare, https://es.slideshare.net/, Accessed 6 April 2018.
6. Prezzi, https://prezi.com/, Accessed 6 April 2018.
7. S. Muryanto, Concept Mapping; an Interesting and Useful Learning Tool for Chemical Engineering Laboratories, *IJEE*, **22**(5), 2006, pp. 979–985.
8. R. G. Campbell, K. P. Weber and R. L. Legge, Exploring Concept Maps as Study Tools in a First Year Engineering Biology Course: A Case Study, *IJEE*, **27**(5), 2011, pp. 985–991.
9. D. C. Shallcross, Using Concept Maps to Assess Learning of Safety Case Studies: The Eschede Train Disaster, *IJEE*, **29**(5), 2013, pp. 1281–1293.
10. Freemind, http://freemind.sourceforge.net/wiki/index.php/Main_Page, Accessed 6 April 2018.
11. Mindmeister, https://www.mindmeister.com, Accessed 6 April 2018.
12. Goconqr, https://www.goconqr.com/es/examtime/, Accessed 6 April 2018.
13. CMap Tool, http://cmap.ihmc.us/, Accessed 6 April 2018.
14. V. Fernandez, P. Simo, I. Algaba, M. Albareda-Sambola, N. Salan, B. Amante, M. Enache, E. R. Bravo, A. Sune, D. Garcia-Almiñana, M. Rajadell and F. Garriga, 'Low-Cost Educational Videos' for Engineering Students: a new Concept based on Video Streaming and YouTube Channels. *IJEE*, **27**(3), 2011, pp. 518–527.
15. Animoto, https://animoto.com/apps/online-video-maker, Accessed 6 April 2018.
16. Screencast, https://screencast-o-matic.com/, Accessed 6 April 2018.
17. Videoscribe, https://www.videoscribe.co/en/, Accessed 6 April 2018.
18. SmartPen, http://www.livescribe.com/es/smartpen/ls3/, Accessed 6 April 2018.
19. E. C. Bristow, J. C. Bruhl and J. L. Klosky, Effect of Supplemental Instructional Videos on Student Performance in Engineering Mechanics Class, *IJEE*, **30**(3), 2014, pp. 566–575.
20. BSCW: Basic Support for Cooperative Work, https://public.bscw.de/pub/, Accessed 6 April 2018.
21. Google Drive, https://www.google.com/intl/es_ALL/drive/, Accessed 6 April 2018
22. Dropbox, https://www.dropbox.com, Accessed 6 April 2018.
23. C. Álvarez, A. Fernández, J. Llosa and F. Sánchez Carracedo Aprendizaje Activo Basado en Problemas, *ReVisión*, **6**(2), 2013, pp. 60–70.
24. N. León-Rovira, Y. Heredia-Escorza and L. M. Lozano Del-Río, Systematic Creativity, Challenge-Based Instruction and Active Learning: A Study of its Impact on Freshman Engineering Students, *IJEE*, **24**(6), 2008, pp. 1051–1061.
25. P. Ponsa, B. Amante, J. A. Roman, S. Oliver, M. Daz and J. Vives, Higher Education Challenges: Introduction of Active Methodologies in Engineering Curricula, *IJEE*, **25**(4), 2009, pp. 799–813.
26. E. Aronson, N. Blaney, C. Stephan, J. Sikes and M. Snapp, *The Jigsaw Classroom*, Beverly Hills, California, Sage Publications, 1978.
27. J. F. Vivas and V. Allada, Enhancing Engineering Education using Thematic Case Based Learning, *IJEE*, **22**(2), 2006, pp. 236–246.
28. D. Harris, A Case for Project-Based Design Education, *IJEE*, **17**(4), 2001, pp. 367–369.
29. W.H. Ip, S. F. Chan and C. K. Choi, An Integrated Problem-based Learning Model for Engineering Education, *IJEE*, **19**(5), 2003, pp. 734–737.
30. A. Kolmos and E. de Graaff, Characteristics of Problem Based Learning, *IJEE*, **19**(5), 2003, pp. 657–662.
31. D. G. Taylor, S. P. Magleby, R. H. Todd and A. R. Parkinson, Training Faculty to Coach Capstone Design Teams, *IJEE*, **17**(4), 2001, pp. 353–358.
32. Essential Project Design Elements Checklist, http://www.bie.org/object/document/pbl_essential_elements_checklist, Accessed 6 April 2018.
33. B. Bowe, C. Flynn, R. Howard and S. Daly, Teaching Physics to Engineering Students using Problem-Based Learning, *IJEE*, **19**(5), 2003, pp. 742–746.
34. C. F. Herreid and N. A. Schiller, Case Studies and the Flipped Classroom, *Journal of College Science Teaching*, **42**(5), 2013, pp. 62–66.
35. G. G. Wang, Bringing Games into the Classroom in Teaching Quality Control, *IJEE*, **20**(5), 2004, pp. 678–689.
36. H. R. Maier, J. Baron, R. G. McLaughlan, Using online Roleplay simulations for Teaching Sustainability Principles to Engineering Students, *IJEE*, **23**(6), 2007, pp. 1162–1172.
37. P. Sancho, R. Fuentes-Fernández, P. P. Gómez-Martín and B. Fernández-Manjón, Applying Multiplayer Role-Based Learning in Engineering Education: Three Case Studies to Analyze the Impact on Students' Performance, *IJEE*, **25**(4), 2009, pp. 665–679.
38. K. Buch and C. Sena, Accommodating Diverse Learning Styles in the Design and Delivery of On-line Learning Experiences, *IJEE*, **17**(1), 2001, pp. 93–98.
39. J. C. González de Sande and J. I. Godino-Llorente, Peer Assessment and Self-assessment: Effective Learning Tools in Higher Education, *IJEE*, **30**(3), 2014, pp. 711–721.
40. N. J. Entwistle, Styles of learning and approaches to studying in higher education, *Kybernetes*, **30**(5/6), 2001, pp. 593–602.
41. D. Parsons, Is There an Alternative to Exams? - Examination Stress in Engineering Courses, *IJEE*, **24**(6), 2008, pp. 1111–1118.
42. M. Martinez, N. Olmedo, B. Amante, O. Farrerons and A. Cadenato, Analysis of Assessment Tools of Engineering Degrees, *IJEE*, **30**(6), 2014, pp 1689–1696.
43. J. N. Craddock and L. R. Chevalier, Development and Formative Assessment of Web-based Multimedia Labware for an Environmental Engineering Laboratory, *IJEE*, **18**(6), 2002, pp. 725–731.
44. C. Rosales, *Criterios para una evaluación formativa: objetivos, contenidos, profesor, aprendizajes, recursos*, Narcea, S. A. de ediciones, 2003.
45. B. C. Williams, B.B. He, D. F. Elger, and B. E. Schumacher, Peer Evaluation as a Motivator for Improved Team Performance in Bio/Ag Engineering Design Classes, *IJEE*, **23**(4), 2007, pp. 698–704.
46. J. M. Williams, The Engineering Portfolio: Communication, Reflection, and Student Outcomes Assessment, *IJEE*, **18**(2), 2002, pp. 199–207.
47. M. I. Campbell and K. I. Schmidt, Polaris: An Undergraduate Online Portfolio System that Encourages Personal Reflection and Career Planning, *IJEE*, **21**(5), 2005, pp. 931–942.
48. D. López, J. L. Cruz, F. Sánchez Carracedo and A. Fernández, A take-home exam to assess professional skills. *41st ASEE/IEEE Frontiers in Education Conference*, *FIE 2011*, Rapid City SD, USA, pp. F1C1–F1C6.
49. K. J. Reid and E. M. Cooney, Implementing Rubrics as Part of an Assessment Plan, *IJEE*, **24**(5), 2008, pp. 893–900.
50. Rubistar, Rubrics for PBL activities, http://rubistar.4teachers.org/index.php, Accessed 6 April 2018.
51. M. J. García, M. J. Terrón and M. Y. Blanco, Desarrollo de recursos docentes para la evaluación de competencias genéricas, *Proceedings of the XV Jornadas de Enseñanza Universitaria de Informática*, *JENUI 2009*, Madrid, Spain, pp. 287–294.
52. M. Valero-García and L. Díaz de Cerio, Self-assessment y coevaluación: estrategias para facilitar la evaluación continuada, *Actas del Simposio Nacional de Docencia en Informática, SINDI*, 2005, Granada, Spain, pp. 25–32.
53. A. Fernández, J. Llosa and F. Sánchez Carracedo, Estrategia para el diseño de laboratorios orientados al aprendizaje continuo, *Proceedings of the XIV Jornadas de Enseñanza Universitaria sobre Informática*, *JENUI* 2008, Granada, Spain, pp. 189–196.
54. D. Suresh, Instant gratification: using clickers as a formative assessment tool to assess learning in a small classroom, *Proceedings of the International Conference of Education, Research and Innovation, ICERI* 2009, Madrid, Spain, pp. 1396–1401.
55. R. Kvadsheim, H. Haugerud, H. L. Hammer, A. Bratterud, and L. Habib. Does Clicker Use Improve Exam Scores? A Controlled Randomized Experiment in a Bachelor-Level Course in Software Engineering, *IJEE*, **31**(2), 2015, pp. 505–520.

56. Richard Byrne, Free technology for Teachers, http://www.freetech4teachers.com/2014/03/seven-good-student-response-systems.html#.WTrGpevyiiN, Accessed 6 April 2018.
57. F. Sánchez Carracedo, Evidencias para acreditar una titulación de grado, *ReVisión*, **7**(3), September 2014, pp. 91–101.
58. A. Gómez, J. González-Rodríguez and C. Ortiz, EMPATÍA: Implantación de un plan de acción tutorial para enseñanzas técnicas, *Proceedings of the XIV Jornadas de Enseñanza Universitaria sobre Informática, JENUI* 2008, Granada, Spain, pp. 139–146.
59. E. Millán, Un sistema dinámico, transparente y flexible para la coordinación de las asignaturas en el marco del EEES, *Proceedings of the XV Jornadas de Enseñanza Universitaria sobre Informática, JENUI* 2009, Madrid, Spain, pp. 143–150.
60. S. Brown and C. Poor, In-Class Peer Tutoring: A Model for Engineering Instruction, *IJEE*, **26**(5), 2010, pp. 1111–1119.
61. B. S. Acar and I. Newman. Students as Tutors—Learning Problem-Solving Skills by Tutoring PBL, *IJEE*, **19**(5), 2003, pp. 712–716.
62. J. J. Escribano and M. J. García, Aventuras y desventuras en métodos docentes. Experiencias aprendidas, *Proceedings of the XIV Jornadas de Enseñanza Universitaria sobre Informática, JENUI* 2008, Granada, Spain, pp. 197–204.
63. F. Sánchez Carracedo, A. Fernández and J. Llosa, La enseñanza de Estructura de Computadores en el EEES, *Proceedings of the XIII Jornadas de Enseñanza Universitaria sobre Informática, JENUI* 2007, Teruel, Spain, pp. 19–26.
64. F. Sánchez Carracedo. Criterios de diseño y condiciones de entorno de un plan de EEEStudios de Grado, *ReVision*, **2**(1), 2009, pp. 21–41.
65. F. Sánchez Carracedo, C. Álvarez, A. Fernández and J. Llosa, ¿Por qué faltan a clase los alumnos? *Proceedings of the XXIII Jornadas de Enseñanza Universitaria de la Informática, JENUI* 2017. Cáceres, Spain, pp. 165–172.
66. F. Sánchez, J. L. Cruz, A. Fernández and D. López, Cómo diseñar una asignatura del EEES: de los objetivos formativos a la metodología y los contenidos, *Proceedings of the XII Jornadas de Enseñanza Universitaria sobre Informática, JENUI 2006*, Bilbao, Spain, pp. 57–64.
67. F. Sánchez, J. Climent, J. Corbalán, P. Fonseca i Casas, J. Garcia, J. R. Herrero, X. Llinàs, H. Rodríguez and M.-R. Sancho, Evaluation and assessment of professional skills in the Final Year Project, *Proceedings of the 2014 IEEE Frontiers in Education Conference, FIE, 2014*, Madrid, Spain, pp. 2352–2359.
68. F. Sánchez Carracedo, J. Climent, J. Corbalán, P. Fonseca i Casas, J. Garcia, J. R. Herrero, X. Llinàs, H. Rodríguez and M.-R. Sancho, A Proposal to Develop and Assess Professional Skills in Engineering Final Year Projects, *IJEE*, **34**(2A), 2018, pp. 400–413.

Fermín Sánchez Carracedo received his BSc in computer science in 1987 and his PhD in computer science in 1996 at the Universitat Politècnica de Catalunya (UPC-BarcelonaTECH). His fields of study include computer architecture, innovation in education and education for sustainability. Since 1987, he has been lecturing at the UPC-BarcelonaTECH Department of Computer Architecture, where he has been an Associate Professor since 1997. He was Vice-Dean for Innovation at the Barcelona School of Informatics from May 2007 to June 2013, and since then he has held the position of Deputy Dean for Innovation. He has more than one hundred publications related to his research topics. Dr. Sánchez's awards include the AENUI's 2017 Award to the Quality and Innovation in Teaching.

Eva Millán received her PhD degree in Computer Science from the University of Málaga in 2000. Currently she is Full Professor at the same university. From 2003, she has been Deputy Dean at *ETSI Informática* at the University of Málaga, Spain, where she has held several positions: Relationships with Students, Innovation in Education and, currently, Academic Affairs. Her research interest includes Intelligent Tutoring Systems and Educational software tools, user and student modelling, Bayesian networks and, more recently, applications of Artificial Intelligence techniques to the development of software tools for architectural design teaching and learning.

Julia González-Rodríguez received her BSc in computer science in 1997. She belongs to the faculty of School of Technology at the University of Extremadura since 2001 where her subjects are related to software programming and interaction design. Her fields of study include innovation in education, accessibility and usability is software artefacts.

Juan José Escribano Otero received his PhD in computer science in 2007 from Universidad de Alcalá. Currently he is Academic director of the Architecture, Engineering and Design School of Universidad Europea de Madrid. His fields of study include innovation in education, teaching STEM skills, PBL, educational software tools, formats and environments for the learning.

María José García García received her PhD in education in 2017 from Universidad Europea de Madrid (UEM). From 2014, she is Director of Student Experience at the UEM, where she has held several academic management positions since 1998 when she joined the Department of Computer Science and Communications: coordinator of the teacher training program of the UEM (2009–2011), Academic Director at Engineering School (2011–2014). She has directed and participated in various research projects on university innovation, skills development and engineering employability, written numerous articles in journals, books and conferences, and received various awards.