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A New Approach for Information System Audit Teaching

Ricardo Pérez-Castillo, Ignacio García-Rodríguez de Guzmán, Mario Piattini
(Information Technologies & Systems Institute
University of Castilla-La Mancha
Paseo de la Universidad 4, 13071, Ciudad Real, Spain
{ricardo.pdelcastillo, ignacio.grodriguez, mario.piattini}@uclm.es)

Moisés Rodríguez
(AQCLab, Camino de Moledores, 13051, Ciudad Real, Spain
mrodriguez@aqclab.es)

Abstract: Today, no matter what market niche a company moves into or whether a business focus is technological, information technologies are its cornerstone in terms of its success and the fulfilment of its business goals. However, an undeniable fact is that technologies, in addition to many competitive advantages, carry many risks that must be properly identified and managed. Organizations must implement control measures to manage the risks. The whole set of control measures build up the Internal Control. However, only the realization of Information Systems (IS) Audit ensures that Internal Control is effective and efficient, and protects the most important assets of the organization, thus ensuring that it can achieve its business goals. This article presents a new vision of teaching in the area of IS Audit, presenting a methodology based on Project Based Learning (PBL) simulating that students belong to a real organization where they must not only develop an Internal Control but also evaluate it through IS Audit techniques. The simulation of a real environment facilitates the acquisition of competencies and knowledge related to IS Auditing, making more attractive the learning process. A tool called HASI has been developed, which implements the detailed workflow depicted in the methodology, allows to automate all the activities carried out by the students. Finally, this article presents the validation of the methodology carried out through the resolution of a practical case with the HASI tool. The validation allows observing to what extent the students perceive the learning of the areas of the IS Audit.

Keywords: Information System; IS Auditing; PBL; Tool support learning
Categories: H.0, L.2.3, L.2.7, L.3.4, L.3.6

1 Introduction

Over recent decades, the use and dependence of software solutions has, to all intents, purposes and sectors in our society, been growing exponentially. It used to be located in huge computing machines, but it now forms part of practically all productive sectors (banking, insurance, transport, and the food industry, as well as in education, medicine, sport, leisure, etc.), and is to be found in any device of our everyday life, from huge processing centres to wearable devices which are capturing information from our daily activity.

From almost the moment we get out of bed each morning, until we get back into it again at night, we use software. This inevitably leads us to think about what an important role software plays in our lives; it encourages us to give careful consideration

to the need for the information systems based on that software to be suitably managed and audited.

Focusing on the business sphere, software has become a keystone, sustaining the main weight of the business value of organizations, and it is a pivotal feature in the support needed for digital transformation. We thus see that companies need software to work within the response time demanded by the market and that they must use software to produce higher-quality goods, storing also all the information about their business. Business use software to carry out analyses of their data and of the market, as well as to make predictions that will enable them to position themselves in the future.

One of the aspects that is vital for organisations nowadays, in the light of all we have just remarked, is that they should be able to trust their Information Systems (IS) that are based on software and which support all of their work [Patón-Romero and Mario Piattini 2016; Piattini et al. 2008]. One of the main tools for assessing whether internal control procedures are established and effective, and/or information systems are developed in accordance with standards, and therefore, if such IS are reliable, is the audit of them.

It should be added here that the importance of auditing is such that, according to the latest survey carried out by [ISO 2018], a total of 1,106,356 valid certificates were reported for ISO 9001 (including 80,596 issued to the ISO 9001-2015 version), an increase of 7% on last year. ISO and IEC's standard for information security, ISO/IEC 27001, experienced the same annual growth of 20% annual increase as the previous year, rising to 33,290 certificates worldwide. In addition, the number of companies that certify their software development processes with ISO / IEC 33000 (previously ISO/IEC 15504) have also increased; even in recent years, a new certification under ISO, the ISO / IEC 25000 standard, has emerged, which allows the quality of the software product and data to be audited [Rodriguez et al. 2015; Verdugo and Rodríguez 2019]. Those audits help organisations to evaluate, improve and certify and reinforce their IS, allowing them to prove that they have implemented a set of controls that are good enough to assure confidentiality, integrity and availability of their IS.

Taking all of the above into account, IS auditing is currently a field that is attracting a great deal of interest at a business level. This has meant that those University subjects whose task it is to give instruction in this area have become especially significant in degree courses such as Information Systems, as well as in Computer Engineering in general.

Considering such a context we are now presenting an improved methodology for teaching IS Auditing with the following characteristics:

- Pedagogical strategy of the proposal: The presented methodology is oriented to Project-Based Learning (PBL) [Krajcik and Blumenfeld 2006]. The approach simulates a context where the students are part of the staff of a fictitious company; there are intended to specify and establish internal controls, and then audit these at a later point in time.
- Taking responsibilities and guiding their learning process: The students feel that they are part of the company, and they have the responsibility to take the best decisions regarding the implementation of the internal control, as well as, pushing themselves to execute a detailed IT Auditing to detect and eliminate the remaining risks in their company. Somehow, the students get used to work in quite a similar real IT department, experiencing (in a controlled

environment) and being trained to face the aforesaid processes. Such implication leads them to identify missing knowledge they have, and request to the teachers when needed.

- All of these core activities are supported by HASI, the tool to developed ad-hoc for the presented methodology. As a result, the students' work is speeded up and they can therefore focus on the essential and most important parts and skills involved in IS auditing. This tool will be presented in detail in section 5.3.

The remainder of the paper is structured as follows: Section 2 presents the most significant international curricula related to IS Auditing. Section 3 summarizes some other tools that are used in the field of IS auditing. Section 4 describes antecedents of the teaching experience carried out by the authors in the field under study in the last 10 years. Section 5 then presents the proposed PBL-based methodology to improve the teaching of IS Auditing, and introduces HASI, the automated support for the methodology. Section 6 presents the results after assessing the use of this new teaching methodology, which employed HASI, by following several use cases. Section 7 presents several ways to improve our proposal, obtained from our experience and after the assessment of the methodology and the HASI tool. Finally, section 8 sets out several conclusions.

2 International Curricula

There are a number of different well-known international teaching curricula that state a series of fundamental guidelines on contents, competences, and skills that should be taught on the different degree courses related to Information Technology (IT).

2.1 The ACM Curriculum

The ACM (Association for Computing Machinery) [ACM 2017a] provides a series of 5 curricula for the degrees of (i) Computer Engineering, (ii) Computational Science (iii) Information Systems, (iv) Information Technology and (v) Software Engineering. In this series, the teaching curriculum that deals with information system auditing is IS, in the main [ACM 2010], although the subject is also tackled to a certain extent in Computational Science [ACM 2013] and Information Technology [ACM 2017b].

The curriculum that is proposed by the ACM for the degree of Information Systems (IS) consists of 7 compulsory core courses, along with 7 others which are elective modules that focus on different roles or specializations.

There are only three core subjects that address some particular topic of IS auditing: Information and Data Management looks at data quality auditing; Business Architecture considers the auditing and checking of standards in business architecture; and Project Management deals with auditing during project management.

Although topics are indeed touched upon, as we have seen above, auditing is dealt with relatively superficially and in less depth in the compulsory courses that have been mentioned above. That is why this curriculum establishes the elective course O5 for auditing and IT controls in IS. The course itself deals with 6 topics:

- The need for information technology audit & controls
- Information technology risks – Business Process and Business Continuity

- Auditing ethics, guidelines, and standards of the profession
- Undertaking an information system audit
- Controls over information and processes
- Controls Assessment

This elective course is closely linked to IT Security Management. In addition, it provides opportunities for discussion of business ethics, and of whether these fit well with examples of companies that have failed due to poor IT auditing and control procedures. In this course, the use of case studies, professional standards, and sample audit software programs are encouraged, in an effort to exemplify concepts covered.

Apart from the curriculum established for the degree in IS, the set of ACM curricula deals with auditing in a way that lacks depth when it comes to the curricula of other degree courses. Within the curriculum of Computational Science [ACM 2013] it is addressed in the subject area of Information Security and Assurance, among the topics which set out the basic principles and concepts. In Software Engineering it is included when the course deals with software validation and verification. In any case, what is dealt with is IS at its most technical level, and no in-depth treatment of the topic occurs. The Information Technology curriculum [ACM 2017b] looks at how to carry out inspections and checks of the code, as well as how to perform auditing and present the assessment results. This topic is covered within the domain of the optional subject of Software Management and Design.

The other two remaining curricula in the ACM series do not take in knowledge areas that include IS auditing. Only a few topics that we could consider as being overlapping ones are included in other areas of knowledge. For example, the curriculum of Software Engineering [ACM 2014] deals with the knowledge area of Software Quality, tackling matters to do with Software Product Quality and Software Process Quality.

2.2 The SWEBOK Curriculum

The SWEBOK (Software Engineering Body of Knowledge) curriculum [Bourque and Fairley 2014], defined by the IEEE CS, is designed for software engineering degrees. That is why IS auditing is not especially relevant in that curriculum, although IS auditing is addressed in at least 2 of the 15 knowledge areas in SWEBOK.

In the knowledge area of Configuration Management there is a topic called Software Configuration Auditing. Amongst other contents, it proposes both a functional auditing of the configuration and an auditing of the infrastructure, as well as of the processes. The scope of this type of auditing is too limited, since it focuses on a specific domain such as configuration management.

Figure 1: Breakdown of topics for the Software Quality knowledge area in SWEBOK [Bourque and Fairley 2014].

Amongst other issues, the knowledge area of Soft-ware Quality encompasses the topic of Software Quality Management Process. Within these processes the content of Reviews and Audits is addressed (see Figure 1). However, this merely focuses on the examination of software engineering artefacts with respect to standards that have been established by the organization or project for those artefacts. Different types of reviews and audits are distinguished by their purpose, e.g., management reviews, technical reviews (including inspections and walkthrough), process assurance audits, and product assurance audits.

2.3 The ISACA Curriculum

The ISACA (Information Systems Audit and Control Association) is the most important international organization dedicated to IS knowledge, certifications, defence, and education in security and assurance, along with corporate governance and management of IT, and compliance with IT.

The ISACA curriculum [ISACA 2012] is divided into five knowledge domains, specifying the topics and syllabus for each of these and the assigned hours.

Unlike the other two curricula already mentioned, it is patently clear that the ISACA curriculum is designed quite specifically for the teaching of information system auditing. This means that it is not likely to have a direct correspondence to an Informatics degree, such as one in Information Systems, or in Computational Science. It seems rather to focus on being the curriculum that pro-poses specific courses on

auditing or on being the one that provides a model for particular subjects within related computer science degrees. In fact, of the three curricula presented above, this curriculum is the one that brings together most comprehensively all the knowledge areas and topics on information system auditing.

2.4 Information System Auditing at Higher Education

Along with the analysis of the most relevant curricula presented in this section, the authors had made a review of existing implementations of such curricula in current degrees for Higher Education.

As far as the authors could find out, there is no public (or existing) information about how to implement the international curricula in related studies at the university. The reasons to this lack of information could be very different, considering for example that maybe the details of such subjects exist but they are not public; these subjects are planned and organized as master classes without an special emphasis on practical/project focus or; this subjects are not a core one in the study plans and thus, not relevant enough to share them in different forums.

Because of that, it is considered very valuable to share the present teaching approach as baseline to discuss possible implementations of the international curricula at Higher Education, as well as the methodological approach to guide the aligned subjects.

3 Existing Information System Auditing Tools

In accordance with what ISACA proposes in its report "Information Systems Auditing: Tools and Techniques" [ISACA 2016], we can differentiate between the following types of tools for IS auditing:

- Questionnaires.
- Spreadsheets and databases for information storage (questions and historical).
- Measurement scripts.
- Computer-assisted auditing tools (CAATs).

Although the content of each of these tools will depend, as is normal, on the domain to be audited (security, processes, government, controls, etc.), questionnaires are perhaps the simplest, quickest to produce and ex-tend; they allow companies to put together a set of questions to check compliance with certain requirements (well-established by a standard, or defined internally in the organization) and serve for use both in self-assessments and to audit third parties.

In second place we can find the use of spreadsheets or databases, which, in a very simple way, have a pre-loaded battery of issues to be checked; they also enable evidence detected during the audit to be stored. Examples of this type of tools are:

- EIP: Processes Implementation Evidence Repository (from AENOR, Spanish Association for Standardization and Certification). The authors of this article, as Head Auditors of AENOR (Spanish Association for Standardization and Certification) have developed, and use, a repository in Excel to control the evidence detected during the audits of ISO / IEC 15504 and ISO / IEC 33000.
- Checklists for verification of compliance of the generic and specific objectives and practices for each of the CMMI models.

- COBIT 5 / DMM Practices Pathway Tool[1]: it al-lows there to be verification of compliance and relationship in the application of two models. The one proposed by COBIT 5 is such a tool, considering the practices proposed by the Data Management Maturity model.

In third place, there are the measurement scripts, which make it possible to execute in an automatic or semi-automatic way the verification of certain types of analysis (static or dynamic) to detect IS issues. This type of tools has the advantage of reducing the user effort; although these tools are not applicable for all types of audits, their use has become more widespread in recent years, due mainly to the importance of aspects such as usability, maintainability and security of information systems [Rodriguez et al. 2019] and the rise of organizations and projects dedicated to their audit, such as the case of OWASP[2] (The Open Web Application Security Project).

Finally, in fourth place we find the tools or frameworks that give full support to practically the entire audit process, and which are known as CAATs or Computer-assisted auditing tools. These tools allow auditors to manage the audit of information systems, from their planning and identification of tasks, to their execution and subsequent preparation of the audit report. Currently, these tools usually offer a web interface to the user, and integrate in a single point the combination of questionnaires, the repository of questions and evidence, and even semiautomatic measurement scripts. Examples of this type of tools can be found in: Appraisal Assistant, developed by the Software Quality Institute, focused on the evaluation of processes under CMMI and ISO / IEC 15504 frameworks; Global Suite, from the company Audisec, which enables the audit processes for multiple ISO standards, such as 9001, 27001, 20000, etc. to be managed; Audit Management Software Solution from the MetricStream company, or the COBIT 5 Self-Assessment Tool from ISACA. However, all these tools are designed to be used directly in the business world, and are complex to manage; most are commercial tools and lack an approach oriented to the education and training of auditors.

Now that the different tools that can be used for the auditing of information systems have been classified, and some of the most well-known ones have been reviewed, we have observed that there is considerable diversity and that we must differentiate when selecting one or several of them, depending on the objective of the audit and the standards whose compliance we intend to audit. However, we can conclude that there are no audit tools that are oriented to the academic world and designed to train future information systems auditors.

4 Previous Teaching Experience

The authors have more than 10 years of experience teaching these contents in the subjects "Informatics System Auditing" and "Information Systems Auditing" (within

[1] http://www.isaca.org/Knowledge-Center/Research/ResearchDeliverables/Pages/COBIT-5-DMM-Practices-Pathway-Tool.aspx

[2] https://www.owasp.org

the context of the academic program of the Computer Engineering degree) of the Faculty of Informatics of the University of Castilla-La Mancha (Spain). In addition, these teachers have taught in various master's and postgraduate programs, where in addition to IS Audit, teachers have given lessons related to auditing, IT Governance and IS Security and Quality.

As a general term, the subjects on Audit and Security in Information Systems have been structured and taught following a mainly theoretical approach. The theoretical nature of these subjects made the teaching-learning process itself tedious (as revealed by some exchanges of opinion with students from different academic years). For this reason, it was important to make a change of approach in the teaching of these subjects.

This view of these courses on the students' part produces a lack of motivation which damages the learning mechanisms that enable them to understand and properly take in the skills, abilities, and contents of IS auditing.

As far as IS auditing is concerned, the first experiences of the authors showed that, although the subjects did include theory-practice assignments, these were just a mere application of the large amount of theoretical content that was being taught. It was thus observed that the simple learning of contents provided no real challenge to the students, apart from simply following the procedures set out for carrying out audits (these are found in the guidelines and procedures established by the ISACA standards), and reading about the experiences which different authors have recorded in educational publications [Piattini et al. 2008].

From the grading perspective, the results did not turn out to be negative, judging by the student grades and pass rate (around 90% annually). Nevertheless, the way of teaching a subject that is essentially more theory-based and difficult to apply in a controlled environment like the classroom demanded an adaptation of the pedagogical approach. It is not only a matter of adapting the syllabus; the students themselves have to modify their concerns and needs to fit in with a different teaching-learning process.

5 Improved Methodology

The proposed methodology is specially developed for 'Information Systems Auditing' subject with 6 ECTS (European Credit Transfer and Accumulation System).This approximately corresponds to 150 hours of student workload that are divided into 40 hours in lectures, 20 hours in lab session, and 90 hours of autonomous work.

The teaching-learning process is directly related to the ability to "excite" and engage the students, which in turn leads to those individuals' being highly-motivated. That is why the way in which teaching is approached in learning about IS focuses mainly on making the student become the main actor in the development of the subject.

The pedagogical plan that is presented has two keystones. First, it is based on PBL [Krajcik and Blumenfeld 2006], where the student, when facing a problem-solving scenario (a project), finds out what tools and knowledge he/she needs at any given time, and looks for ways to acquire them; they do this either on their own or with the help of their instructor. Secondly, the method is aided by a HASI, presented in detail in section 5.3.

5.1 Teaching Goals

The main goal of this subject is to provide students with the knowledge and the tools necessary for the development of IT audits in IS. This principle objective can be broken down into two sub-objectives. The aim is to:

- Understand the context of information technology in the organisations, as well as the control mechanisms that these bodies establish for themselves to ensure that they align well with the business goals (i.e., how the organisations create Internal Control – which we shall call IC from now on).
- Identify and apply IT auditing techniques and tools for the assessment of the control mechanisms which organisations create around their technological infrastructure (in other words, IC auditing of the organisations).

5.2 Sequence of Activities

With this break-down of the main goal, it is obvious that the objective has within it an implicit need to have solid knowledge about the structure and development of the IC that must later be audited. Teaching this subject (in a PBL way) therefore takes place by means of the following steps/activities (see Figure 2).

5.2.1 Creation of a company in the IT Field

On the first day of class, the students receive a message, via the "Virtual Campus" (a virtual framework of the university intended to organize subjects and share documentation with the students), telling them that they have been hired as members of the IT department of an organisation whose business goals are very clear. These members of the organisation are divided into sub-groups, to each of which a business goal is assigned. The new "professionals" are informed of the working scope of the organisation and of the market niche, as well as of their importance as a department that will establish all the technological infrastructure.

5.2.2 Training period

The new members of the company go through a time of training, in which the teaching staff, following the masterclass methodology, give instruction in the basic theoretical content for students to begin the work on their own. The training period presents concepts such as the basic aspects of auditing and internal control. During this time of training, the students are divided into sub-groups of 3-5 members. Each one of these groups is given one or two high-level objectives, and will have a person who is in charge, who will also be the spokesperson for their group.

5.2.3 Configuration of the technological infrastructure of the company

After this training period, each group must decide what technological infrastructure their organisation will have. To that end, the groups analyse the business goals and, depending on what these are, they will choose an IT set of technologies and infrastructures that they consider necessary to carry out the business objectives assigned to them. After that, the group delegates will meet and identify the infrastructures they have in common, as well as those which are complementary, together with the

dependencies. In this way, they will decide on a final set of IT resources that will work in the service of the organisation.

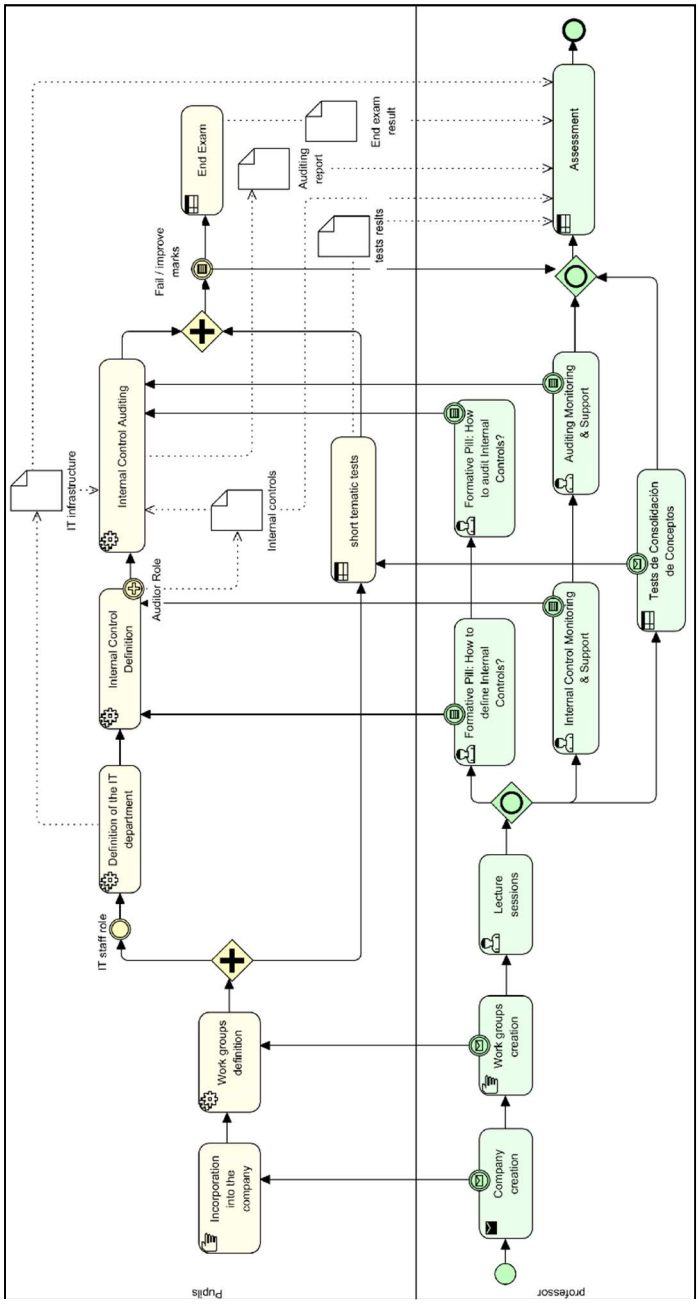

Figure 2: Sequence of activities in the proposed approach.

5.2.4 Development of Internal Controls

Once the common technological infrastructure for the organisation has been decided, each group, bearing in mind the business goals of their firm, will develop a part of the IC that makes it possible to keep all these risks that are related to IT and the business goals under control.

This is one of the points where the work groups will face the issue of how to identify risks, how to develop mechanisms of control, and how to align this IC with the business objectives.

At this point, the teachers will provide support to the students by means of brief instructions given in masterclasses and "knowledge pills". These are provided on the virtual campus in the form of a "documentary library of the organization". The students will thus learn to handle COBIT (Control Objectives for Information and related Technology), on their own (while receiving some instructions). COBIT is an auditing guide par excellence, used by IT auditors in their profession,

Although COBIT is a specific document in itself, it allows the student to become familiar with the concept of IT risk, as well as the areas of review (or control dimensions of the IT), and they learn of how to identify the specific aspects that should be kept under control if they are to comply with the general objectives assigned to each group. COBIT, at this stage of learning, serves as a reference guide to students, seeking to identify which aspects have to be submitted to strict control in order to lessen the possibility of problems appearing due to the presence of information technology. Following the COBIT approach, the students will design an IC with no vulnerabilities, or at least only with the residual risks that it has not been possible to mitigate.

It is at this point, when the students identify all the risks that need to be controlled, that they must face the challenge of designing specific IC to lessen the risks. They have not yet received any training on how to do this, and they will have to resolve the problem by using different means, consulting reports and documents, which the group will look for on their own. As the IC structure may vary a great deal, depending on the particular field of auditing they are working on (economy, IT, telecommunications, quality, etc.), the work groups will function autonomously in their endeavour to figure out a general IC structure. This will be reported back to the other groups in later feedback, so that a uniform control pattern may be agreed on.

This work in groups and in "departments" will allow the students to understand perfectly the concept of control in the field of technology, and to appreciate its importance in the IC context of an organisation. Once the IC development of each group has been finished, the IC of the organisation is considered to be ready, for in theory, all the risks related to its technological infrastructure will have been dealt with.

5.2.5 Auditing Internal Controls

Having played the role of IT professionals who have developed IC in a company in the IT field, the groups now radically change their role, to tackle the second objective mentioned at the beginning of this section. This is to acquire the skills and tools of an IT auditor. At this point, each one of the work groups should audit the IC that another group has carried out at an earlier stage, in the work groups; this stage is when they must learn the IT auditing process.

To do so, the students, under the guidance of their teachers, analyse the documentation of the ISACA and especially of the CISA certification, where each particular team learns what the standard process of IT auditing is that should be adapted to the specific IC they have been assigned. In addition, the work groups should now become familiar with the theoretical aspects and standardised guidelines that are the tools of the trade in following the IT auditing process and in establishing the way the job of auditor must be carried out.

These materials are mainly the "Auditing Standards and Guidelines" (in which the students learn to identify, represent and maintain the evidence of any IT auditing process, and find out how to develop audit reports, etc.). They also learn to use COBIT, which now acts as guide in the identification of "aspects that should be covered" in the IC being studied. Students can of course work with other auditing guides that they may find. However, the teaching staff will recommend the best documents to use in undertaking the profession of IT Auditor within the industry. This task ends with the development of an audit report which will comply with ISACA's "Auditing Guidelines and Standards"[3]; this should be made up of certain documents with a given format, whose rigorous quality ought to be similar to what would be expected of a professional auditor.

5.2.6 Student Assessment

The current assessment of the course establishes three important landmarks in the marking process (see Figure 2):

- Assessment of the Internal Control: teachers evaluate using a rubric that the students of each IC development group are familiar with.
- Assessment of the Auditing Report: similarly, and using a rubric, the audits are evaluated by identifying such aspects as what the audit covers, and how rigorous the auditing process has been.

Final exam: part of the marks corresponds to a final exam which the students must pass. In this there is an assessment of theory and of practical cases where the students must act as auditors and choose the best option. Teachers do, however, offer an alternative to the final exam, which is the opportunity to pass a number of smaller exams in a multiple-choice test format. These are usually given at random, evaluating theory content which (i) is discussed in class when a particular situation in the projects requires it, or (ii) the students should now master at a particular point in a project. These tests aim for the students to feel motivated to keep content up-to-date, keeping a check on how the subject is going (something that happens naturally, thanks to the way projects progress in class).

5.3 Tool-aided learning

Together with the new teaching-learning methodology, we have developed HASI, a web application that can support most of the activities involved in the sequence described in previous sections. Activities that can be supported by this tool are

[3] http://www.isaca.org/Knowledge-Center/ITAF-IS-Assurance-Audit-/IS-Audit-and-Assurance/Pages/IT-Audit-and-Assurance-Guidelines.aspx

displayed in the process of Figure 2 with the *gears* icon in the top-left corner of each activity. As can be deduced after analysing the highlighted tool-aided activities, HASI supports two user roles in the application for students: IT staff and Auditor. In this way, students can first of all define business goals for their company; then internal controls goals are established from such business goals according to the COBIT specifications, which are included in HASI (see Figure 3). After that, students, as IT staff, can provide a certain implementation for different internal controls as regards the internal control goals selected previously.

After internal controls have been defined by students, every work group is requested to audit internal controls of a different group. In this point, students use HASI with the auditor role (see Figure 4). They can add comments, and upload working papers as evidence of their comments (see Figure 5). In addition, HASI supports the planning and carrying out of interviews with the IT staff of the audited company.

In this way, some students can interview others, asking them about the internal control they defined. Interview notes can be registered in the application (see Figure 6). Having completed the auditing process, students as auditors can automatically generate reports to be included in the final auditing report they must deliver.

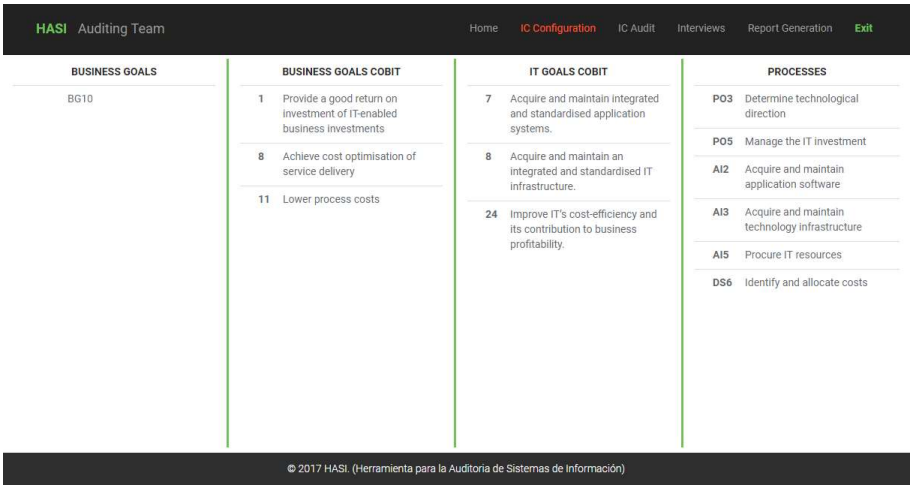

Figure 3: HASI. Internal Control as defined by students playing the IT Staff role

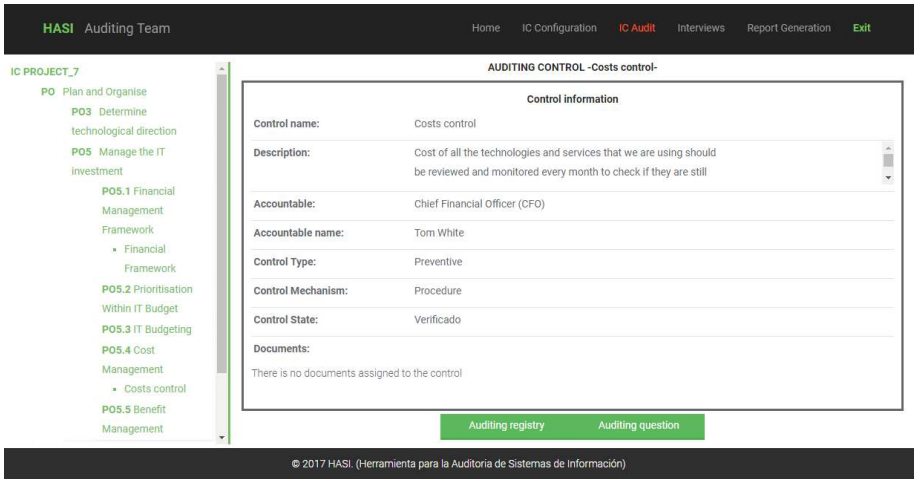

Figure 4: HASI. Summary and planning for Internal Control auditing

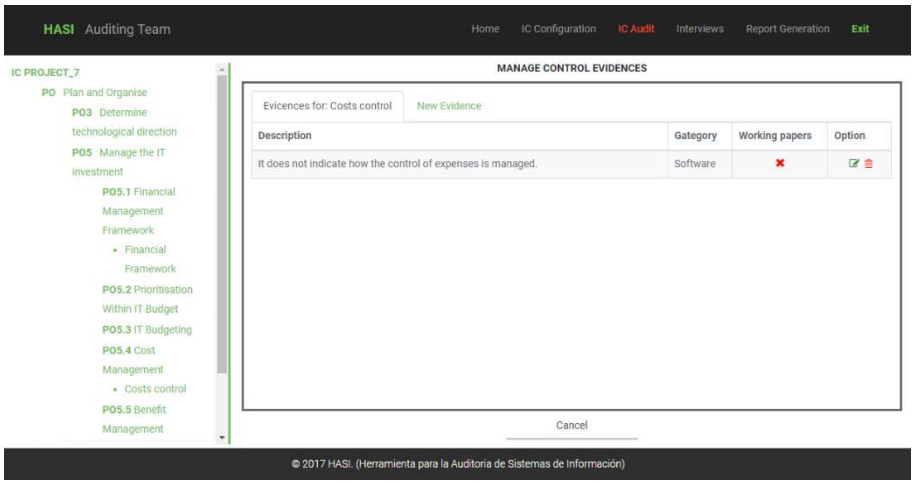

Figure 5: HASI. List of evidence found after auditing an Internal Control

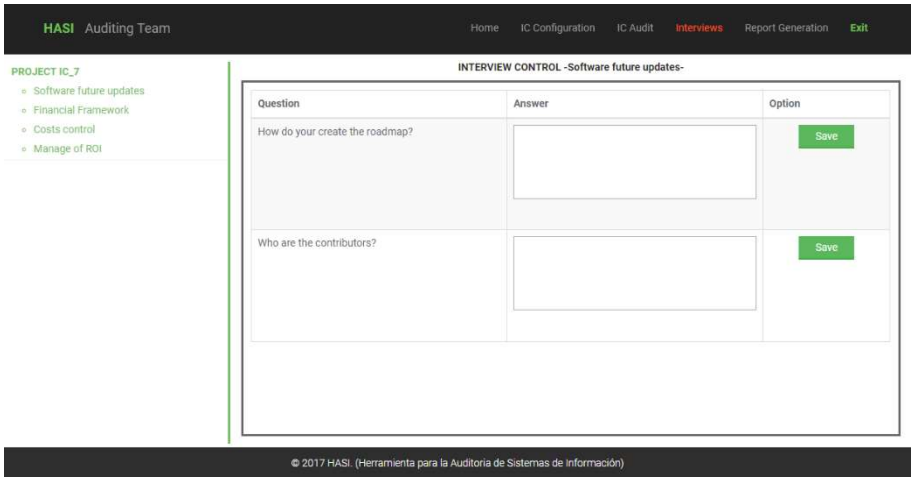

Figure 6: HASI. Auto-generated form for gathering information through auditing interviews

The lecturer can also interact with HASI in order to manage work groups, configuring when a group plays the role of an Auditor or IT Staff, among another setup configurations. Each year, the lecturer is also responsible for creating and configuring the different student work groups In our opinion, the use of these tools improves the teaching-learning process, since students who now deal with a PBL method can accelerate the construction of their projects by focusing on the essential activities of the IS auditing process.

6 Methodology Assessment Results

Previous sections have discussed a new point of view for tackling the teaching and learning process of IT Auditing. To summarise, both a methodology to organize the subject and an automated support have been presented: the methodology establishes a structure of activities (mixing theory and the project execution), and the HASI tool automates most of the activities proposed by the methodology.

In order to outline to what extent the present methodology is useful, this section presents a validation which has been carried out by means of the HASI tool.

6.1 Definition and context

The students of the subject have been working with HASI throughout two semesters in two different years, experimenting to see how the theoretical content could be put into practice, and following the sequence of activities set out by the methodology (see Figure 2). The practical work the students have been performing is based on the context of a simulated IT organization (see ANNEXE A), called “ISA Enterprises” with a very clear market focus and a starting set of business goals.

The teachers of the subject configure the set of work groups with the students, who in turn will play the roles of (in the first part of the subject) Internal Control Staff and (in the second part of the subject) the IT Auditing Staff.

After experimenting with HASI throughout the semester (in two different years), the students are required to fill in a questionnaire (anonymously) according to their own experience (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). We ask students to answer the questions following a Likert scale with 5 levels of agreement: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D) and Strongly Disagree (SD). Only the last question (Q18) is formulated to be answered by means of a free text, explaining possible suggestions for improving HASI. The questionnaire was filled in by 19 students after finishing their projects and their exam evaluation of the subject, 10 students in 2018, and 9 students in 2019.

6.2 Perception of HASI and the methodology

Figure 7 presents the results of the questionnaires. The Y-axis presents the results of the questions Q1-Q17 (Likert scale questions), while the X-axis shows the percentage of answers for each question. The chart in Figure 7 makes it easy to outline several conclusions about the perception of the students as to how they have learnt by using HASI, and in turn, how the methodology improves the teaching of IT Auditing.

Id	Question/Assertion
Q1	The HASI tool is attractive
Q2	The HASI tool is easy to use
Q3	HASI is helpful in learning how to develop the Internal Control
Q4	I would prefer to learn to develop the Internal Control manually with the use of a tool
Q5	The guidance of the tool is suitable for performing the Internal Control
Q6	The HASI tool is helpful in learning how to develop an IT Audit
Q7	I would prefer to learn how to develop an IT Audit with the use of a tool
Q8	The guidance of the tool is suitable for performing an IT Audit
Q9	Compared with manual development of the IC and the IT Auditing, by using the HASI tool I could make better use of the time available.
Q10	It is possible to carry out real collaboration with the people of my work group
Q11	The HASI tool is good study material
Q12	The HASI tool helps to understand concepts more quickly
Q13	The HASI tool provided me with good experience
Q14	While I was using the tool, I felt as if I was deploying my knowledge in an industrial context
Q15	I would prefer to use the HASI tool right from the start in the subject instead of carrying out the projects manually
Q16	The HASI tool contributes to my learning
Q17	The HASI tools show me some of the real complexities of a real IT Audit project.
Q18	I suggest it might be useful to implement the following improvements in the HASI for the next academic year/s:

Table 1: HASI evaluation questionnaire

Questions Q1 and Q2 deal directly with the use of HASI, dealing with the concepts of attractiveness and ease of use. As may be seen, 90 and 80% of the students responded

strongly agree in the first year while 70 and 55% responded agree in the second year, agreeing that such characteristics are present in the tool. These two questions show that there is no attitude of rejection towards HASI, so at first glance, the technological support for the subject is suitable.

Questions Q3 to Q5 tackle one the cornerstones of the subject: learning about and developing the Internal Control (IC) of the company. HASI reflects the contents of the theoretical sessions regarding IC development, proposing a flow of activities and resources that allow the students to create from scratch the set of controls that builds up the IC. On one hand, there is general agreement (Q3, 70% of SA in 2018 and the same percentage of A in 2019) regarding the usefulness of HASI in learning how to develop an IC; this result is consistent with Q5, which shows complete agreement (50% SA and 50% A in 2018 and 20% SA and 60% A in 2019) with the suitability of the process proposed by HASI for performing the IT. On the other hand, it is surprising, taking into account the answers of Q3, that Q4 reveals that 50% of the students (around 40% D and 15% SD for both years) would prefer to carry out the development manually, working directly with the different auditing guidelines and managing all the documentation involved themselves. This mismatch could be caused by several factors; for example, there were some issues with the document upload functionality of the platform, as well as a few usability concerns regarding the navigation through the guidelines.

Questions Q6 to Q8 deal with the other cornerstone of the subject, which is the execution of an IT Audit. The role played by the different teams of students now changes from Internal Control Staff to IT Auditing Staff. 90% of the students (50% SA and 40% A in 2018 and 70% SA and 20% A in 2019) state that HASI is helpful in learning how to conduct an IT Auditing project. HASI follows the flow of activities presented in the theory lessons of the methodology presented, so the students can see how HASI helps them to put a (simulated) IT Audit into practice.

Q8, which focuses on the guidance that HASI offers in performing the process of IT Auditing, had also obtained almost the same result that Q6 in both years. However, once again question Q7 presents a similar rejection pattern to the one that we observed previously in Q4, with only 20% SA and a direct 60% of disagreement (50% D and 10% SD in both years). As before, it was interaction issues that caused this perception. The interaction patterns with HASI do sometimes make some activities that should be performed in the context of the execution of an IT Auditing project seem very repetitive; there were, in addition, minor problems with managing documents on the platform. The lack of satisfaction regarding Q4 and Q7 are finally confirmed by the results of Q15, which tackle the hypothetical possibility of performing all the activities of the projects by means of HASI, rather than practising them first by hand and then going on to perform a whole project with HASI (around 50% of general agreement for both semesters studied). Q15 results confirm that HASI needs to be improved in certain usability aspects.

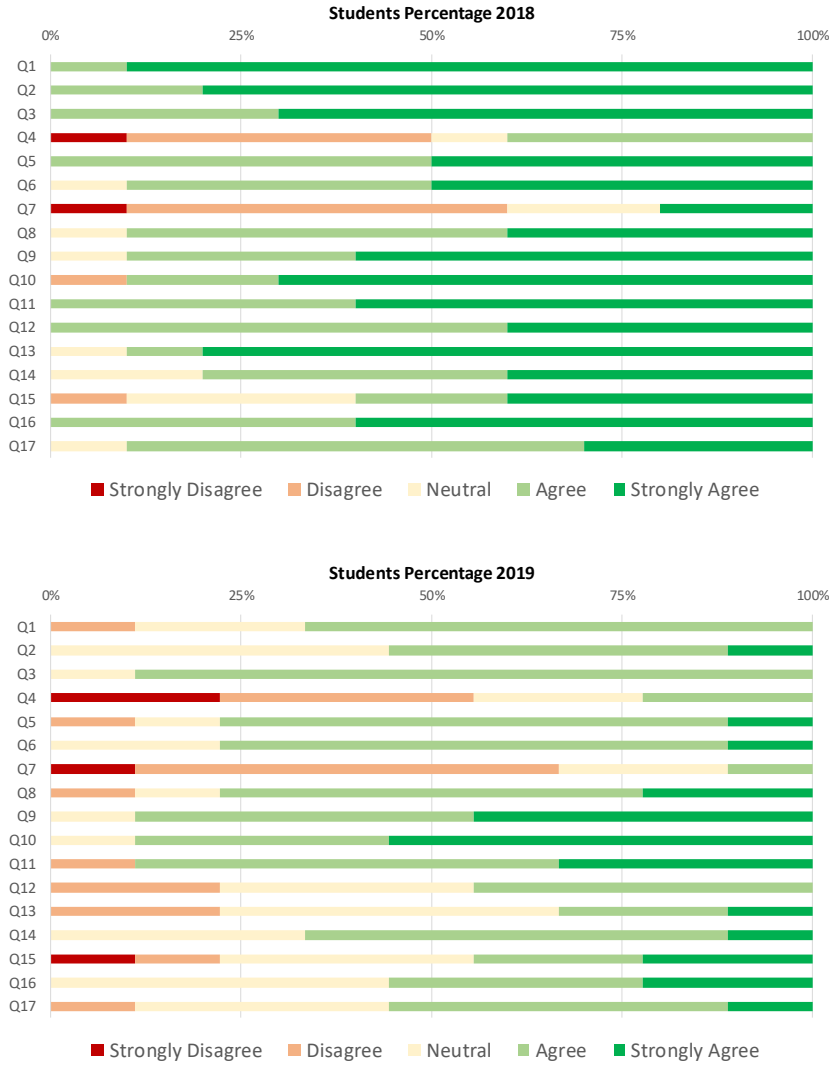

Figure 7: Results of the questionnaires for two years.

However, Q9 reveals, with 90% of general agreement, that HASI saves time when putting the concepts of IC and IT Auditing into practice, and it in turn leads the students to experience a more realistic Auditing experience (as the 80% in 2018 and 65% in 2019 of general acceptance at Q14 shows); it also aids them to perceive, to a certain extent, the true complexities of a real situation (90% of positive perception at Q17 in 2018 and a slightly lower percentage of 60% in 2019). In the real world, such complexities imply working in close collaboration and in teams, as HASI enables

students to do, and this is what the students perceived (around 70% SA and 20% A for Q10 in both years).

Questions Q11 and Q12, with 90% of general acceptance, state that HASI is a good support for the subject, being considered good study material which in addition, helps the students to understand better all the contents that are discussed in the sessions on the theory involved or in what is provided as additional reading. Q11 and Q12 align with the perception of the students about the real contribution of the tool to the learning process (100% of general agreement at Q16). Although, almost 45% of students defined Q16 questions as neutral in 2019. These good results in Q11, Q12 and Q16 support the result of Q13 (90% of general acceptance in 2018 with slightly poorer results in 2019), where the students agree that they are provided with good experience by means of use of the tool to support the subject.

Finally, in addition to the detailed analysis presented in this section, the box plot of Figure 8 combines and summarizes the overall perception of the students throughout the last two years. As can be seen, the students offer "Totally Agree" or "Agree" answers to the questions, on average, and only a few present disagreement with the current state of the automated support of the methodology. Figure 8 therefore displays a positive perception of the students regarding the HASI tool and its impact on the learning process, while also flagging up the weak points that will be removed in the new release of the tool.

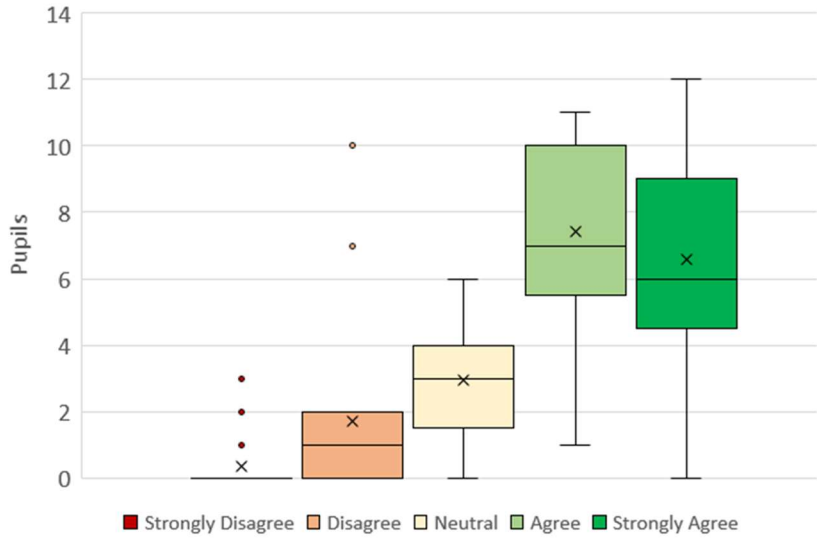

Figure 8: General view of the students' perception after two-years assessment

6.3 Lessons Learnt

When we talk about teaching, we must always take into account the most important asset we have. We refer to the human factor, namely our students. They are of greater importance than methodologies, learning tools, study programmes and syllabuses.

Thanks to the wide experience that our teaching staff has accrued in the subject of Information System Auditing (and other similar subjects), something important has been proven. It is that the most important factor when improving the level of acceptance on the part of the students, and the amount of benefit they obtain from the subject in general (IT auditing in particular), was the involvement of the student him/herself in the learning process by simulating a real setting, or one that is similar to a current industrial setting.

It made the student feel that the overall direction and efficacy of the IT in "their" organization depended on the proper functioning of the professional (both as a member of an IT department and as a member of the group of auditors). The degree of commitment on the part of the students, along with the greater amount of knowledge acquired (either through a master class or through research), has led to there being a positive response in the learning process on the part of these individuals. This meant that not only were contents learnt; this learning went on to form an integral part of their professional competence, making what was acquired become consolidated knowledge and skills.

The evolution proposed as a way of addressing the subject was in response to the evolution in student profiles. Learners have increasingly been demanding experience, rather than being limited to working within the classic theory and theory-practice paradigm.

In addition, this practical focus of the subject, when it involves mechanical tasks such as the development of the internal control or the execution of certain parts of an IT Audit, could be quite overwhelming. The automation of most of these through the use of the HASI tool is therefore quite positive, as the results of the questionnaire presented in section 6.1 have shown. HASI, together with the project-based learning methodology applied in the subject, reveals that the acquisition of IT Auditing concepts is substantially improved when compared with traditional approaches.

Nonetheless and according to the results of the questionnaire, there is a margin of improvement for HASI, and some functionalities can be redesigned in order to improve the perception of the students and thus, their experience while taking the subject.

7 Improvement Proposals

As was remarked at the beginning of this article, quality of software and IT is one of the main aspects to bear in mind wherever there is an intention to achieve excellence in organisations. The IT, which is a facilitator in managing to reach the business goals has developed a host of quality standards related to, services, security, etc, all of which are put into effect in the form of quality management systems, control mechanisms which eventually go on to form part of the IC of the companies involved. The scope of the development and auditing of the IC, as we have pointed out above, is determined by the guidelines and standards of the ISACA (as in the case of COBIT).

Nevertheless, an auditor who is carrying out his or her professional role has to face not only IS auditing, but also the auditing of compliance with standards such as ISO 20000, ISO 27000, ISO 33000, ISO 25000 (either as an internal auditor or as an external auditor of any certification body). One of the paths to improvement of this present proposal, therefore, aims to include the certification mechanisms of standards related to IT, setting out to give the students an even closer view of how the profession of IT auditor works in our present-day world.

It must also be stated that, from the point of view of the international curricula that were analysed, the topic of the technological auditing of software products and projects is dealt with very superficially in the subject. Yet, as the ISACA curriculum demonstrates, these topics are significant indeed. That curriculum contains the topic blocks of "Information Systems Acquisition, Development and Implementation", along with "Operation, Sustainability and Support of Information Systems; these make up 40% of the total curriculum. As a proposal for improvement, therefore, there will be the addition of an auditing of a software project, which will be carried out in the context of the fictitious organisation of the present proposal. In this way the students will have to carry out the audit on software project management and the underlying software product that is being developed. All of this will be done using the same PBL methodology as before.

8 Conclusions

IT has, over time, become a catalyst in organisations (which these days are completely dependent on IT), allowing them to reach their business goals). New technologies, nonetheless, do not only provide benefits; the job of IT auditors is to be able to analyse IS, so that they can assess the performance of the IC in organisations. This is even more necessary in a technological society like the present one, where quality, security and governance of technology have become primary requirements. It is in this context that the figure of the IT auditor takes on an extra role: he or she is not just the person in charge of assuring IT performance; their task is also to be an active agent in assessing the proper implementation and certification of the main quality standards related to IT.

With all these issues in mind, this paper presents a methodological proposal for the teaching of IT auditing. It is a proposal that is underpinned by more than a decade of experience in the field of IT auditing on the part of the teachers involved in it. That methodology turns students into active subjects in the learning process, discovering the contents, tools and skills, and then putting them into practice. All of these contents and skills, far from being dealt with in a purely theoretical manner (as has happened in traditional methodology), are now tackled in a way that is practical and dynamic, simulating a real setting where the student faces decisions similar to those they might find in a real company when they finish their studies and begin to practise their profession as auditor.

The experience of the last few years has demonstrated to the teachers involved that this method of approaching the subject in question gives the students a competitive edge, not only improving their learning process, but also preparing them for the ever-evolving realm of IT, where change is constant and highly prepared professionals are demanded. For such reason it is crucial the training coverage of the present approach which prepare students for quickly being enrolled in an IT department to deploy tasks

as (i) the implementation of the Internal Control, (ii) the execution of IT Auditing projects (either as external IT Auditors or as part of the Control Self-Assessment function of the company) and, (iii) the preparation of a company for successfully pass an IT Auditing (which is a consequence of their two previous points).

This new vision of the IT Auditing subject, intended to enable students to quickly join a highly demanding market, is currently giving good results, as the assessment of the methodology highlights. This validation has been carried out by means of a case study that was developed by using HASI, the tool that automates the execution both of the development of the case study and its execution. The questionnaire points to the fact that the HASI tool, and in turn the methodology, lets them learn the theoretical contents in a very easy way by means of practical activities. The key point is that HASI helps automate the most overwhelming tasks, giving them the chance to place their attention on more intellectual tasks and making the most of their time. The assessment also provides several interesting insights, such as certain usability concerns that should be improved in the next launch of the HASI tool. We believe that, according to the experience presented, the use of HASI improves the teaching-learning process, since students who now deal with a PBL method can accelerate the construction of their projects, focusing on the essential activities of the IS auditing process.

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