

# INFORMATION AUDIT TRAINING IN COMPUTER SCIENCE AS A SERIOUS GAME

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## Abstract

Information System Audit is one of the hardest and more challenging disciplines in the context of computer science degree. It is owing to auditing of information systems requires a great experience and several skills, as well as depth knowledge about all the stakeholders involved in the auditing industry (e.g., chief executive/information officers, auditing customers, certifiers, auditors, etc.). This fact together with a lack of motivation can cause a strong discrepancy between potential and success in learning with students. This lack of motivation is mainly due to auditing is a bit outside of more technical disciplines of computer science degree. This explains why highly skilled students show poor performance under the same dispositions while one can find averagely gifted among the best of the group. It is hardly possible to attain good achievements without motivation. To deal with these two problems (i.e., auditing unfamiliarity and lack of motivation) a new teaching-learning strategy based on serious game was conducted. This strategy transformed a traditional practical exercise based on case studies into a serious game based on the distribution of students in groups, assignment of roles and real-life, industrial case studies. Lessons learned of this experience demonstrated that students were highly motivated and the auditing learning process was improved.

Keywords: Information Audit, Computer Science, Serious Game, Innovation.

## 1 INTRODUCTION

Information System Audit is a relatively new subject in most common international syllabi of software engineering and computer science [1, 2]. Information System Audit concerns the audit, control, monitor, and assess of the enterprises' information technology and business systems. An Information System Auditor are professionals with the assurance knowledge, skills, experience and credibility to leverage standards, manage vulnerabilities, ensure compliance, offer solutions, institute controls and deliver value to the enterprise [3].

Information System Audit is one of the hardest and more challenging disciplines in the context of computer science degree. At least, there are two main challenges related to the Information System Audit teaching. The first challenge is due to the fact that auditing of information systems requires a great experience and several non-technical skills. The technical component of this discipline is higher regarding, for example, other computer science areas. The second challenge is that Information System Audit requires an in-depth knowledge about all the stakeholders involved in the auditing industry, e.g., chief executive/information officers, auditing customers, certifiers, auditors, and so forth [3].

The aforementioned challenges together with a lack of motivation in students due to such differences regarding other subjects can cause a strong discrepancy between potential and success in learning with students. This lack of motivation is mainly due to auditing is a bit outside of more technical disciplines of computer science degree. This explains why highly skilled students show poor performance under the same dispositions while one can find averagely gifted among the best of the group. It is hardly possible to attain good achievements without motivation [4].

Motivation combines objectives and motives in a certain manner and depict the general activating direction of the current way of life. Motivation exists if the person has distinct motives and a set of goals [5]. Thereby an internal impulse exists, which leads to action. There are numerous definitions of the term. According to *Dresel and Lämmle* motivation is a psychic process that performs the initiation, control, straight preservation and evaluation of purposeful action [6]. Motivation is a hypothetical construct and cannot be determined and monitored directly from the outside. Only indicators derived from behaviour, thoughts and feelings can give information.

Several kinds of motivation are to be distinguished: The most basic distinction is between intrinsic motivation and extrinsic motivation as shown in [7]:

- *Intrinsic motivation refers to inherently interesting or enjoyable action. An example for this kind of motivation is a student performing his exercises out of curiosity or interest.*
- *Extrinsic motivation refers to doing something because it leads to a different outcome. An extrinsic motivated student would also fulfil his exercise, but only because he hopes to get positive results like good marks or recognition. This means external influence effects the student and contributes to their willingness to learn.*

Intrinsic motivation has appeared as “an important phenomenon for educators as a natural wellspring of learning and achievement” and “results in high-quality learning and creativity” [7]. In contrast extrinsic motivation is only effective as long as outer structures give impulses. Nevertheless, both forms cannot be separated clearly and are often overlapped.

This paper attempts to address the lack of motivation of students of Information System Audit in order to improve the teaching-learning process. To deal with the motivation problem a new teaching-learning strategy based on serious game has been conducted in a computer science degree of a Spanish university. This experimental strategy transformed a traditional practical exercise based on case studies into a *serious game* based on the distribution of students in groups, assignment of roles and real-life, industrial case studies.

*Serious Games* are games designed to teach and educate players about some of the dynamic complexities of the field in a safe and inexpensive environment [8]. In the serious game learning system, students are able to understand technical and non-technical concepts in a team-based environment by using a role-playing gaming strategy. The study also investigates the effect of the system on student learning achievement and attitude [9].

Having conducted the experimental teaching-learning experience about Information System Audit based on serious game, the most relevant lesson learned was that the application of this experimental strategy proved to be positive in terms of a higher motivation of students, and therefore, in terms of marks obtained by most students.

The remainder of this paper is organized as follows. Section 2 introduces the Information System Audit field. Section 3 disseminates how serious games can help to improve the student motivation. Section 4, the core section, presents in detail the experimental teaching-learning experience conducted. Finally, Section 5 discusses lessons learned from this experience.

## **2 INFORMATION SYSTEM AUDIT**

Information is a key resource for all enterprises, and from the time that information is created to the moment that it is destroyed, technology plays a significant role. Information technology is increasingly advanced and has become pervasive in enterprises and in social, public and business environments [10]. As a result, today, more than ever, enterprises and their executives strive to:

- *Maintain high-quality information to support business decisions.*
- *Generate business value from IT-enabled investments, i.e., achieve strategic goals and realize business benefits through effective and innovative use of IT*
- *Achieve operational excellence through the reliable and efficient application of technology*
- *Maintain IT-related risk at an acceptable level.*
- *Optimize the cost of IT services and technology.*
- *Comply with ever-increasing relevant laws, regulations, contractual agreements and policies.*

Over the past decade, the term ‘governance’ has moved to the forefront of business thinking in response to examples demonstrating the importance of good governance and, on the other end of the scale, global business mishaps [11].

Successful enterprises have recognized that the board and executives need to embrace IT like any other significant part of doing business. Boards and management—both in the business and IT functions—must collaborate and work together, so that IT is included within the governance and management approach. In addition, legislation is increasingly being passed and regulations implemented to address this need [12].

Information System Audit provides a comprehensive framework that assists enterprises in achieving their objectives for the governance and management of enterprise IT. Simply stated, it helps enterprises create optimal value from IT by maintaining a balance between realizing benefits and optimizing risk levels and resource use. Information System Audit enables IT to be governed and managed in a holistic manner for the entire enterprise, taking in the full end-to-end business and IT functional areas of responsibility, considering the IT-related interests of internal and external stakeholders. Information System Audit is generic and useful for enterprises of all sizes, whether commercial, not-for-profit or in the public sector.

The most well-known framework for auditing IT companies and their Information systems is COBIT (Control Objectives for Information and Related Technology). COBIT is the latest edition of ISACA's globally accepted framework, providing an end-to-end business view of the governance of enterprise IT that reflects the central role of information and technology in creating value for enterprises. The principles, practices, analytical tools and models found in COBIT embody thought leadership and guidance from business, IT and governance experts around the world [13]. COBIT is based on five key principles for governance and management of enterprise IT (see Fig. 1) [14]:

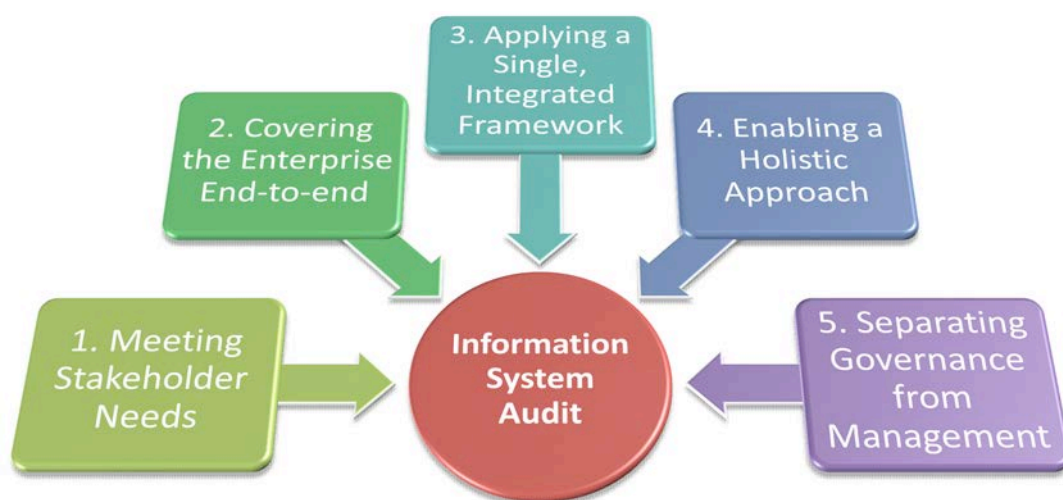


Fig. 1. Information System Audit Principles

1. **Meeting Stakeholder Needs.** Enterprises exist to create value for their stakeholders by maintaining a balance between the realization of benefits and the optimization of risk and use of resources. Information System Audit provides all of the required processes and other enablers to support business value creation through the use of IT. Because every enterprise has different objectives, an enterprise can customize COBIT 5 to suit its own context through the goals cascade, translating high-level enterprise goals into manageable, specific, IT-related goals and mapping these to specific processes and practices.
2. **Covering the Enterprise End-to-end.** Information System Audit integrates governance of enterprise IT into enterprise governance:
  - It covers all functions and processes within the enterprise; COBIT 5 does not focus only on the 'IT function', but treats information and related technologies as assets that need to be dealt with just like any other asset by everyone in the enterprise.
  - It considers all IT-related governance and management enablers to be enterprise-wide and end-to-end, i.e., inclusive of everything and everyone—internal and external—that is relevant to governance and management of enterprise information and related IT.
3. **Applying a Single, Integrated Framework.** There are many IT-related standards and best practices, each providing guidance on a subset of IT activities. COBIT 5 aligns with other relevant standards and frameworks at a high level, and thus can serve as the overarching framework for governance and management of enterprise IT.
4. **Enabling a Holistic Approach.** Efficient and effective governance and management of enterprise IT require a holistic approach, taking into account several interacting components. COBIT 5 defines a set of enablers to support the implementation of a comprehensive governance and management system for enterprise IT. Enablers are broadly defined as

anything that can help to achieve the objectives of the enterprise. The COBIT framework defines seven categories of enablers:

- Principles, Policies and Frameworks
  - Processes
  - Organizational Structures
  - Culture, Ethics and Behavior
  - Information
  - Services, Infrastructure and Applications
  - People, Skills and Competencies
5. **Separating Governance from Management.** The COBIT 5 framework makes a clear distinction between governance and management. These two disciplines encompass different types of activities, require different organizational structures and serve different purposes. COBIT 5's view on this key distinction between governance and management is:
- Governance, which ensures that stakeholder needs, conditions and options are evaluated to determine balanced, agreed-on enterprise objectives to be achieved; setting direction through prioritization and decision making; and monitoring performance and compliance against agreed-on direction and objectives. In most enterprises, overall governance is the responsibility of the board of directors under the leadership of the chairperson. Specific governance responsibilities may be delegated to special organizational structures at an appropriate level, particularly in larger, complex enterprises.
  - Management plans, builds, runs and monitors activities in alignment with the direction set by the governance body to achieve the enterprise objectives. In most enterprises, management is the responsibility of the executive management under the leadership of the chief executive officer (CEO).

Together, these five principles enable the enterprise to build an effective governance and management framework that optimizes information and technology investment and use for the benefit of stakeholders.

### 3 SERIOUS GAME

Games have been used to train and educate players for many years in many different fields [8, 15-17] and are based on learning and development theories such as problem-based learning [18], decision science [19], and experiential education [20]. Unfortunately, games have been found to be more expensive and administratively demanding to develop and use than some other forms of instruction or research [21, 22]. Despite that, serious games have several advantages; most of them lead to a higher motivation of participants involved.

For instance, it has been noted that the human capacity to understand the implications of our mental models and to accurately trace through even a small number of causal relationships is fairly limited [23]. Yet, a game is a visible and physical representation of a problem space; a captured mental model. As such, they are places to trial new ideas and to experiment with established theories [24]; to replay these theories as many times as needed; places where time and space can be contracted or expanded; places where it is acceptable just to try different things and where more might be learned from failure than success [25].

Even so, there are some dangers to be heeded when using games. Games are just one representation of how the world works. Therefore, it is potentially dangerous to have players leave the gaming environment with the belief that the strategies that were effectively employed in playing the game are directly transferable to the real world [26]. Participants should ideally be provided with more information than just the game to help them wisely discriminate between what may or may not work outside the game itself [27].

Serious games are based on simulation as the main principle. Simulation is defined as the process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behaviour of the system and evaluating various strategies for the operation of the system [28]. In addition, simulation presents a way to combine the relevant aspects of a real environment with the flexible capabilities of simulation experiments. These capabilities include the

opportunities to compress or expand time, control sources of variation, to stop and review, to restore the state of a system, to facilitate replication and to control the level of detail [29].

Those characteristics add a lot of flexibility to real (class room) projects. Students and lecturers are not captured in the operational necessity to produce real software to enable lively learning. This enables the focused exploration of different software processes in a limited timeframe. Various situations can be introduced to exercise and cope with.

Serious game experimentation becomes part of the learning process without endangering software development efforts in a real class project. Even situations, which would be completely inconceivable due to limited resources, could be examined by students. While all these simulation characteristics already offer new learning experiences to students, which go beyond lectures and class projects, they are most engaging and motivated when made into games [17].

The student motivation is higher with serious games since they are competitive activities that are creative and enjoyable, which are bounded by certain rules and require certain skills [30]. The interactive and highly engaging character of games motivates learners to take responsibility for their own learning, which leads to intrinsic motivation [30]. Digital Game-Based Learning (DGBL), a term coined by *Prensky*, who defined it as any marriage of educational content and computer game [21] fosters learning through the integration of engaging game elements including challenges, fantasy, control, continuous interactive feedback, competition and pleasant rewards. Adding game elements to a simulation provides a more engaging and motivating learning environment and thereby a more successful one.

#### 4 THE INFORMATION AUDIT TRAINING EXPERIENCE

The teaching-learning experience focus on the Information System Audit subject in the Computer Science degree at the Computer Science Faculty in Ciudad Real at University of Castilla-La Mancha, Spain. According to the mentioned syllabus, the Information System Audit subject is taught in a half year term (in the first semester) in the fifth course of five ones in total. This subject implies 3.75 credits. This subject is optional in the aforementioned syllabus thus only 14 students were enrolled in the subject during 2012-13 year.

The subject program is structured in seven different modules (see Fig. 2). On successful completion of this subject, students should be able to:

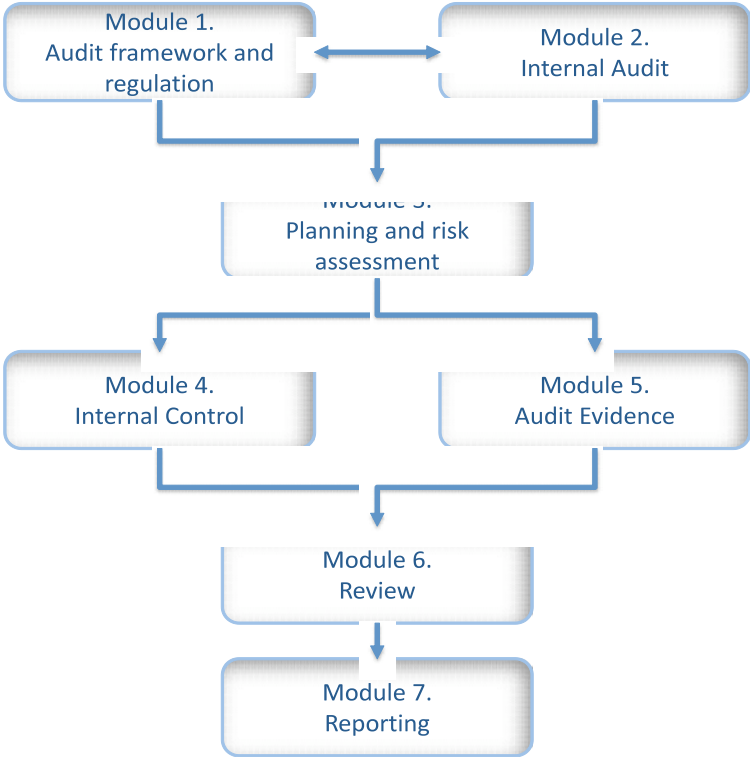


Fig. 2. Relational diagram of Information System Audit capabilities and subject modules

- Module 1 explains the nature, purpose and scope of assurance engagements including the role of the external audit and its regulatory and ethical framework
- Module 2 explains the nature of internal audit and describing its role as part of overall performance management and its relationship with the external audit
- Module 3 demonstrates how the auditor obtains an understanding of the entity and its environment, assesses the risk of material misstatement (whether arising from fraud or other irregularities) and plans an audit of financial statements
- Module 4 describes and evaluate information systems and internal controls to identify and communicate control risks and their potential consequences, making appropriate recommendations
- Module 5 identifies and describe the work and evidence required to meet the objectives of audit engagements and the application of the International Standards on Auditing
- Module 6 evaluates findings and modify the audit plan as necessary
- Module 7 explains in detail how the conclusions from audit work are reflected in different types of audit report, explaining the elements of each type of report

The teaching-learning experience consisted of a serious game. This experimental strategy transformed a traditional practical exercise based on case studies into a *serious game* based on the distribution of students in groups, assignment of roles and real-life, industrial case studies. The following paragraphs depict the players and their roles in the game, the rules and goals of the game, as well as the material used to conduct the simulation game.

#### 4.1 Goals

The goal of this serious game was to conduct an audit of a real-life information system in a simulated way, i.e., with a time and resources restrictions. Participants were working in groups in order to achieve the best audit. The criteria to evaluate which is the best audit were the following:

- Mission, vision, goals and values
- Governance policies and practices
- Culture and management style
- Models for roles and responsibilities
- Business plans and strategic intentions
- Suggestions about how to improve the information system audited

#### 4.2 Material

The information system under audit was PRECISO [31, 32], a reverse engineering application to discover Web services from existing relational databases. PRECISO minimizes the heterogeneity problems since databases can be integrated in SOA environments. This application also advocates the reuse of legacy databases, thus extending the lifecycle of databases. Finally, PRECISO shortens development time because the WS generation is automatic and instantaneous.

Students were provided with all the material and documentation related to PRECISO. In that documentation were included a clear list of project goals, the list of requirements, analysis and design diagrams based on Unified Modelling Language (UML), implementation details, testing reports, as well as some success cases in which the application was effectively used.

#### 4.3 Players and Roles

The reduced number of students, 14 in total, benefited the setup of the teaching-learning experience as a serious game. The students were divided into two different groups with seven students each. The simulation of this serious game lies in the fact that both groups were considered as two competitor auditing companies, which were in charge of auditing PRECISO, the mentioned information system. In order to define both groups, two students were voluntarily defined as CEOs of both companies. The first responsibility of these two heads was to define a name for their fictional companies as well as to choose one by one member for their companies. Having conformed both companies, each company defined and assigned their own roles to each student of the group (e.g., auditor, secretary, etc.).

The role of the teacher in this experience was the CIO of a third company which demanded the audit of the PRECISO system. The teacher chose PRECISO as the information system under study since this software was analysed, designed and implemented by the own teacher of the subject, who was involved in that development project four years ago as the main developer during his final degree project. This role was important as a source of information to conform the audit of the system. Anyway, this role was reactive, i.e., it did not provide information unless the teacher is interviewed. This practice simulates the real-life interviews between auditors and the staff of the company that is being audited.

#### 4.4 Rules

The following set of rules explains how the game was carried out in terms of space and time restrictions, interactions with other roles, and how to win.

- After the definition of both companies, each one must be allocated in opposite classroom places to avoid any interaction between both groups.
- Both groups have to define their own schedule to accomplish the required audit during two hours.
- In case auditing companies want to interact with the CIO of the company which hired them, a sole member of the auditing company each time would request information by means of interviews previously arranged.
- After two hours, each auditing company have to present their audit report by indicating negative and positive points as well as suggestions for improving all the weakness detected.
- The winner group would be the company which presents the most complete and precise audit report in terms of the mentioned evaluation criteria presented in section 4.1.

### 5 LESSONS LEARNED

Having conducted the experimental teaching-learning experience about Information System Audit based on serious game, the most relevant lesson learned was that the application of this experimental strategy proved to be positive in terms of a higher motivation of students, and therefore, in terms of marks obtained by most students. To sum up, serious games promote motivation in at least the following four areas (see Fig. 3), which have been found to be very effective in practice.



Fig. 3. Four areas to promote motivation by means of serious game

#### 5.1 Inspiring the curiosity of the students

Serious game as a simulation of the reality demonstrated to be helpful to tell stories about own experiences. Students are all of a sudden very excited when teachers tell of their experience,

especially when it comes to failures during auditing software systems. If it is possible to create a link of the story to the Information System Audit subject, we can be certain that something will “stuck” in students’ minds. It is obvious that this is not always easy to realize.

With the usage of this serious game the leisure interests and extracurricular experiences are integrated in the material exchange when using this method. This method does not only satisfy the interests of the students, but does even more importantly pose an achievable goal for them. Ideally, the achieved goal is also practicable beyond the boundaries of the university course and therefore sustainable.

## **5.2 Promoting the independence of students**

As people responsible for their own behaviour we do not like to be under external pressure, they can only be motivated when some room of manoeuvre exists. For the role of lecturers we can derive that they should enable autonomous learning environments. For example they can enable students to choose exercises and team members on their own. Lecturers should take students seriously and treat them as equally matched partners for communication. They should solve problems together with their students. We can give students of our Information System Audit courses a lot of freedom to choose the exercises they want to solve and how they want to solve.

## **5.3 Adapting the subject’s difficulty to the students prior knowledge of the matter**

In order to raise the desire to learn it will be practical to adjust the content of the courses and exercises to the learners. The courses should be ideally structured in a way that contributes to the generation, improvement and maintenance of learning motivation. Learning became more enjoyable by means of the proposed serious since it (i) resumes current knowledge; (ii) is not too high for learners; and (iii) offers something new for learners.

Only if learners consider themselves to be efficient and successful they may enjoy learning and they may develop intrinsic motivation. But we have to point out that not every subject or every learning content may be arranged in a way that every learner in a learning context could profit from it or could be encouraged to a motivated behaviour.

## **5.4 Creating incentives for learning**

The students are able to present their own solutions as different audit reports in the experimental experience on Information System Audit. Due to the fact that there often exist several solutions to a single problem in auditing as a part of the subject under study, there are often a number of excellent solutions from students as well. Here the student recognition plays a big role in our experience based on serious game. This signifies that since there are game’s winners, the motivation increases. Solutions which are special or brilliant will be included in sample solutions for all students by the lecturer. Students make their solutions available to the lecturers with great pleasure. They are happy about that form of recognition.

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