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Teaching Ethics and Sustainability to Informatics Engineering Students, An Almost 30 Years' Experience

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Abstract: A significant number of universities where engineering is taught, acknowledge the importance of the social and environmental impact of the scientific and technological practice, as well as the ethical problems it presents, and the need to provide their students with courses covering this as a subject. This paper presents 29 years of teaching courses with the subject of social, environmental, and ethical issues to students of Informatics Engineering. The table contents and its evolution over the years will be analyzed, plus the different teaching strategies applied, with emphasis on the collaborative learning methodologies to facilitate critical thinking and debate. During the experience, the course incorporated the subject of History of Informatics which proved to fit in the course. While the subject of Ethics and Sustainability is increasingly being regarded as an important matter to learn by future ICT engineers, the courses covering it remain as optional in the curriculums. This should change.

Keywords: teaching; computer ethics; environmental issues; social issues; computer science

1. Introduction

1.1. The Potential of ICT to Raise Ethical and Social Issues

Technology has a clear influence on the way we live, our culture, the economy, how society functions, and our relationship with our environment. Information and Communication Technologies (ICT) are not an exception.

When comparing our early 21st-century globalized society to how the world was back in the 1940s, when the first modern computers were developed, it is obvious the historically unprecedented rapid changes human civilization has experienced. The potential of ICT to raise ethical and social issues that differ from those raised by other technologies has been discussed since the beginning of digital computers [1]. The accelerated pace of innovation in this field amplifies the issue.

The rapid changes in computing processors were predicted by Gordon Moore, Fairchild's R&D director, in 1965. He stated that the density of transistors was doubling every 18 months and would keep doing so for the foreseeable future. This prediction known as Moore's Law has been true for the last 55 years.

Ray Kurzweil dug on the history of computing and found out that Moore's Law had been at work at least since 1900 before electronic digital computers were invented. According to Kurzweil, the exponential pace in which technological change is accelerating is independent of a particular technological paradigm–valves, transistors, integrated circuits, microchips - but an unstoppable process that is bound to continue in new paradigms, like for example quantum computing or bio-computers.

According to Kurzweil, the technological development we are going to experience during the 21st century will be equivalent to 20,000 years of progress at today's pace [2].

The impact of ICT in society and its exponentially accelerated pace of development puts a special ethical responsibility on the shoulders of the ones who are developing and bringing to society the new tech advancements: engineers and scientists. Hence, the impact of ICT in society and the environment and its ethical implications is a key subject to teach in all engineering graduate and postgraduate programs related to ICT.

1.2. Education on ICT, Ethics and Social Issues

The IEEE/ACM Computer Science Curriculum 2013, identifies social issues and professional practice as one of the key knowledge areas that computer undergraduate students must learn. These guidelines state "the education that undergraduates in computer science receive must adequately prepare them for the workforce in a more holistic way than simply conveying technical facts. Personal attributes (such as risk tolerance, collegiality, patience, work ethic, identification of opportunity, sense of social responsibility, and appreciation for diversity) play a critical role in the workplace". Graduates should recognize the social, legal, ethical, and cultural issues inherent in the discipline of computing. They must further recognize that social, legal, and ethical standards vary internationally. They should be knowledgeable about the interplay of ethical issues, technical problems, and aesthetic values that play an important part in the development of computing systems [3].

Although the environmental, social, and ethical aspects of technology have been included in some undergraduate computer science curricula for over twenty years, traditionally, it is usually focused on viewing computer technologies through an ethical lens [4]. Thus, most of the literature relates to the study of ethics in the computer science curriculum; that's why the related work starts with ethical aspects in computer science.

The term "computer ethics" was coined in 1978 by Walter Maner. Maner noticed that ethical decisions are much harder to make when computers are added to the problem, hence there was a need for a different branch of ethics for when it came to dealing with computers. Maner's work generated a lot of interest in this new field in university circles in the late 1970s and 1980s. The first textbook about computer ethics was written in the 1980s by Deborah Johnson [5].

It wasn't until 1991 that the study of ethics was introduced into Computer Science curricula [6]. An ACM/IEEE joint committee was established and they created a new curriculum for computer science that included in it computer ethics. It was the first time that the study of computer ethics was introduced in computer science curriculum.

It was also in 1991, that the first conference on Computing and Values founded by America's National Science Foundation took place in the USA [6]. It was organized by Terell Byrum and Walter Maner. This multidisciplinary conference put in touch philosophers, scientists, computer engineers, business managers, and professionals.

In Europe, the Barcelona School of Informatics (Facultat d'Informàtica de Barcelona-FIB) at Universitat Politècnica de Catalunya (UPC) in 1991 included in the Informatics Engineering graduate program courses on "Social Impact and Professional Ethics of Informatics" created by professor Miquel Barceló [7] and "Informatics History" [8] created by professor Ton Sales. Professor Barceló wrote monthly columns about social and ethical issues of ICT in the Spanish edition of the Byte magazine, and other publications for the professional and general public [8–27]. These two courses mark the start point of the teaching experience documented in this paper.

In 1995, the Centre for Computing and Social Responsibility (CCSR) was founded at De Montfort University (United Kingdom) with Professors Simon Rogerson, Terry Ward Bynum, and Don Gotterbarn among the staff. Rogerson became Europe's first Professor in Computer Ethics in 1998 and provided important contributions to the historical debate about the impact of strategic, managerial, and ethical issues of ICT within organizations [9].

1.3. Approaches to Teach Computer Ethics

There are many approaches on how to introduce the study of ethics in ICT curricula. Some are focused on the importance of the process of ethical decision making, which places an emphasis on the process it takes to reach conclusions [10,11]. Kavathatzopoulos's studies concentrate on the development of moral thinking.

Other researchers focus on professional practice considering that ethics education should focus on practical applications, on the ability to solve ethical problems morally or technically [12].

Being knowledgeable on a professional code of ethics is becoming a requirement in ICT ethics education [13]. In this line of work, Johnson proposes ethics education as a set of activities that provides students with basic knowledge about "codes of ethics and standards of behavior", develops their skill at interpreting and applying these codes and standards, and increases the likelihood that the students will be prepared to handle ethical issues once they enter in their professional lives [14]. According to Johnson, the students also need to develop reasoning capabilities and motivations (the will to take action). In this line of thought, Samson [15] states that codes of ethics provide valuable guidelines to achieve ethical behavior and to assess moral responsibility in the profession.

Nygard [4] base their teaching strategy not only on ethics but also on the social implications that help students in ICT develop their ethical reasoning skills and an appreciation for the complex impact that technologies have on society. They work by exposing the students to as many of the cultural, social, legal, and ethical issues in the discipline of computing as possible in order to broaden their appreciation and understanding of complex issues. In an approach similar to the one taken by Barceló at UPC, and Gordon at the University of Hull [16].

Spiekerman focusses on the need for incorporating ethics into the research and development process itself, by integrating computer science with philosophy and management [17].

Patrignani in his Ph.D. thesis addresses how can universities prepare the next generation of computer professionals so that they are "ethically grounded"? He uses the concept of Slow Tech as a baseline for the analysis. Patrigani states that the ICT supply chain should take into account three dimensions: social desirability, environmental sustainability, and ethical acceptability. These three concepts are proposed as a joint requirement for a new approach to ICT: a good, clean, and fair ICT [18].

Other contributions present surveys of the growing collection of topics in ICT ethics [19–21]. This last quantitative survey shows an increase in the number of publications in the area that indicates a trend toward growing awareness that underlines the increasing importance of the field.

Nonetheless, the distribution of topics is broadly constant, with no ethical issue emerging completely new or disappearing entirely, and the order being relatively static. The majority of the conclusions of papers surveyed are not practical, but rather call for more research and discussion. In many cases, more practical guidance for specific stakeholders or groups might help.

Despite the various experiences in the teaching ethical aspects of ICT and, even if there are now some common methods recognized for integrating these subjects in the computer science curriculum, it is very difficult to teach ethics of ICT to engineers. In engineering, and in particular in computer science, the challenge is even greater, due to the continued rapid evolution of technology.

In addition to technical skills, professional skills are also included in engineering education, and in computer science education in particular. ABET's EC 2000 criteria contain a set of professional skills that include process and awareness skills [22].

Process skills include communication, teamwork, and understanding ethics and professionalism, while awareness skills include engineering within a global, economic, environmental and societal context, lifelong learning, and knowledge of contemporary issues.

Starting with the study of ethics in engineering education, a brief examination of the methods used in engineering schools showed a six stream approach: codes of ethics, case problems, moral theory, problem-solving heuristics, humanistic readings, and service-learning [23,24].

Bowden proposed an ethics course based on case problems, ethical theory, acting in the public interest (or whistle-blowing), the study of codes of ethics, and the role of the professional society [25].

According to Gotterbarn, more than being required to learn ethical theory and philosophical argumentation, computer science students need to be taught that there are ethical issues relevant to their professional practice, to recognize these issues [26].

Johnson and Martin think that philosophers who have not had appropriate training in computer science are not capable of appreciating key technical issues and thus cannot effectively teach computer science courses, because some certain ethical issues involving computer technology are particular to the field and require precise technical understanding [14].

The rest of the paper is organized as follows. In section two the introduction of sustainability in the UPC is explained. In section three the syllabus and methodology of first iteration of the course "Social Impact and Professional Ethics of Informatics" is presented. In section four, the variations of syllabus and methodology that we currently use is explained. In section five we present de results of informal polls answered by students during these years and we discuss the evolution of the subject. Finally in section six we present the conclusions of this work.

2. Incorporating Sustainability in the Curriculum of Informatics

2.1. Adding the Sustainability Component in ICT Ethics

As the 1990s went by, the notion of sustainability as part of the social responsibility of engineers started to be incorporated into the very statutes of some universities.

In its statutes the UPC defines itself in article 4.2 as a "knowledge-generating and transmitting entity, that must promote the protection of the environment and sustainable development, both in terms of training and research activities and institutional ones". Further on, the article 93 states the "importance of the social and environmental impact of scientific, technological, humanistic and artistic activities, as well as the ethical problems raised by any of these activities, and that UPC must offer courses related to these issues in the framework of the curricula [28].

In December 1995 the UPC organized and hosted in the city of Terrassa the 1st International Conference on "Tecnologia, Desarrollo Sostenible y Desequilibrios" (Technology, Sustainable Development, and Imbalances [29]).

As a consequence of this conference, in 1996 a UNESCO Chair was created at UPC to deal with technology, sustainable development, imbalances, and global change. The UNESCO Chair of Sustainability coordinated the research on the sustainability field, created a master, and a Ph.D. program [30]. Years later it grew into the current University Research Institute for Sustainability Science and Technology at UPC (https://is.upc.edu/en).

The previously mentioned Social Impact and Professional Ethics course of the UPC's School of Informatics, under the supervision of Prof. Miquel Barceló who was involved in the UNESCO Chair of sustainability, started incorporating aspects of sustainability in its syllabus.

In 2003, the new curriculum for the Informatics Engineering graduate program incorporated a new course called "Social and Environmental Aspects of Informatics", merging the former plans courses "History of Computer Science" and "Social Impact and Professional Ethics in Informatics" including sustainability and environmental components included in the syllabus and the very title.

Here we find a practice shared in most universities to our knowledge: the incorporation of the teaching of sustainability in the courses of ethics and social aspects in ICT.

2.2. Enter Competencies

In 2009 the Barcelona School of Informatics approved just six years later, yet another new curriculum to adapt to the new European Union EHEA framework, also known as the "Bologna Process" [31].

The new curriculum adapted to the EHEA Framework conserved the course "Social and Environmental Aspects of Informatics" (from now on referred to as its Catalan acronym: ASMI) from the previous curriculum of 2003, which remained, however, an elective course.

The new Bachelor's Degree in Informatics Engineering incorporated the system of competencies. These competencies are defined as a combination of knowledge, skills (intellectual, practical, social, etc.), attitudes, and values that enable individuals to solve problems and to carry out tasks in a specific academic, professional or social context [32].

A specific transversal competency for "Sustainability and Social Commitment" was defined in the curriculum. Professors Joan Climent and Jose Cabré acted as coordinators of the effort in several courses in the curriculum to work on this competency.

The specifics about this "Sustainability and Social Commitment" were defined back in 2004 in the frame of the "2nd International Conference on Engineering Education in Sustainable Development" held in Barcelona that year. Experts in education, faculty, researchers, and students that attended the conference approved the declaration of Barcelona where the following requirements were defined for engineering professionals [33]:

- To understand how their work interacts with society and the environment, locally and globally in order to identify potential challenges, risks, and impacts.
- To be able to work in multidisciplinary teams.
- To adapt the current technology to demands imposed by sustainable lifestyles, resource efficiency, pollution, prevention, and waste management.
- To be able to apply holistic and systemic approaches to problem-solving, and posses the ability to move beyond the tradition of breaking reality down into disconnected parts.
- To participate actively in the discussion and definition of economic, social, and technological policies to help redirect society towards more sustainable development.
- To apply professional knowledge according to deontological principles and universal values and ethics.
- To listen closely to the demands of citizens and other stakeholders and let them have a say in the development of new technologies and infrastructures.

It is worth mentioning the work done by the group of faculty and researchers in the STEP project, adapting Christian Felber's "Common Good Economy" Matrix into a methodology for the students to self-evaluate the sustainability of their Final Degree Projects in Informatics engineering [34].

In the UPC's School of Informatics, there are two coordinated approaches to teach sustainability: For one part it is taught as a specific subject in the ASAI course. For another part is taught as a transversal competency in several courses and in the Degree Final project.

3. The First Iteration of the Course: Social Impact and Professional Ethics of Informatics

As previously mentioned, the Barcelona School of Informatics at UPC included in the 1991's Informatics Engineering graduate a course on "Social Impact and Professional Ethics of Informatics" (The Catalan name for the course is "Impacte Social i Ètica Professional Informàtica", we will use its acronym: ISEPI to refer to this course from now on).

To develop this course, similar programs from prestigious universities worldwide were analyzed. Among other findings previously exposed, the research showed that in other universities, these courses were usually taught by humanities departments, usually history and philosophy departments. However, UPC is a technical university that only teaches engineering, architecture, and sciences programs. This course was not designed by specialists in humanities venturing in the domain of technology, as was the case in other universities, but by engineers versed in the domain of humanities.

3.1. The Course Objectives and Contents

The ISEPI course was defined in 1991 with the following Teaching objectives:

- To stimulate reflection on the effect of science and technology in society.
- To learn about legal issues on the use of computers, the current legislation, and its effects.
- To know the ethical and deontological aspects of professional activity in the field of informatics.

To achieve these objectives the contents of the course were structured this way (see Table 1):

Table 1. The course contents of the ISEPI course.

1. Society and Technological Change
1.1 - Science and technology: social impact
1.2 - Introduction to the philosophy of technology
1.3 - Energy, resources, and sustainability
1.4 - Technology and its creators
1.5 - Ethics and deontology of technical activity
1.6 - The process of technological change and the diffusion of technology
1.7 - Evaluation and control of technologies
2. The Social Issues of Informatics
2.1 - The "revolution" of information technologies
2.2 - Economic effects of computerization
2.3 - Macro-ergonomics: social interaction between computer users
2.4 - Micro-ergonomics: physiology and psychology in the Person/Computer relationship
2.5 - Internet and the network society
3. The Informatics Profession: Ethics and Professional Responsibility
3.1. The informatics profession(s)
3.2. Subjects and agents of responsibility in informatics
3.3. Professional ethics and deontology in informatics
4. Informatics and Legislation
4.1. Computer science and legislation
4.2. Computer fraud and crime
4.3. The legal protection of information.
- Data vulnerability.
- Data privacy.
4.4. The legal protection of software ownership
4.5. Computer contracts
4.6. Electronic contracting
4.7. Electronic documents
4.8. The electronic transfer of data and money

3.2. Dicussion of The 1990's Sylabus

This syllabus was developed in the early 90s, in hindsight, we can appreciate how several points of the course were especially relevant. Let us analyze briefly a few:

1. Point 1.6 "The process of technological change and the diffusion of technology" has proven especially relevant with Moore's law remaining valid during all these years, and the time of widespread social adoption of new technologies becoming each time shorter.
2. Point 2.5 "Internet and the network society", was at the time pretty much an academic bet. Back then the Internet was something in the fringe, to the point that the courses on computer networks not even teach TCP/IP due to its apparent lack of relevance.
3. Point 4.3 "The legal protection of information, data vulnerability and data privacy", is currently in the center of the social and political debate. But it was an obscure theme back then.

4. Point 4.4 "The legal protection of software ownership" was very relevant, with the inception of the Free Software and Open Source Software movements.
5. Point 4.8 "The electronic transfer of data and money", was more centered on banking informatics and its effect on the globalization of markets and society. This discussion precedes the ongoing disruption brought by the blockchain.

3.3. Course Methdology

The ISEPI course followed a hybrid teaching approach, clearly divided into two parts: theoretical and practical. The course theory was imparted in lectures given by the professor, usually with the help of slides (actual vinyl slides on a projector). At the end of the course, the students had to go through a written exam.

The practical part of the course consisted of 3 sets of activities performed inside and outside of the lecture room.

- Book readings. The students had to read 2 books from a list of proposed readings and deliver an essay about each one.
- Case studies performed in class. The case was presented by the professor and some questions were proposed to the students. Working in groups, the students wrote answers to the teacher's questions. Each group presented their answers to the whole group and a debate ensued. At the end of the session, each student had to present a conclusive report, which indicated whether she changed her opinion during the debate and why. This collaborative learning methodology was inspired by the training provided by the ICE (https://www.ice.upc.edu)
- Research case. Working in groups, the students had to research a theme proposed by the professor or themselves. The students had to write a short paper with their findings and present it to their peers in class.

4. The Second and Third Iterations of the Course: Social and Environmental Issues of Information Technologies

Since the change of the millennium, the Barcelona School of Informatics has changed twice the curriculum for the engineering degree. A first modification came in 2003 due to the changes in the discipline. In 2009 the curriculum had to change again to comply with the European Higher Education Area (EHEA) framework, also known as the Bologna process.

With the 2003 curriculum, a new course was designed to replace the old ISEPI course. This course was named "Social and Environmental Issues Of Information Technologies" or "Aspectes Socials i Mediambientals de la Informàtica" in Catalan. We will use the Catalan acronym: ASMI, to refer to this course from now on. ASMI was designed as a merge of the old ISEPI course with the History of Informatics course.

In 2009 the adaptation of the curriculum to the EHEA framework required minor modifications to the course ASMI, mainly in the methodology to include the system of competencies of the EHEA framework.

This means that the ASMI course has existed in two curriculums, undergoing slight changes in the contents and methodologies. Almost every year the professors of the course have experimented with minor modifications in the contents and methodologies. Not all the contents or methodologies described have been always in place or continued to be applied.

To avoid repetitions we will focus on the main differences between ASMI with the previous ISEPI course, discussed in the previous point in contents and methodologies.

4.1. Adding the History of Informatics to the Syllabus

The first difference introduced in ASMI was the merge with the contents and objectives of the course of the history of informatics. This was a good decision because, in our opinion, basic knowledge about the history of the field of informatics-starting in the early 19th century with Charles Babbage and Ada Lovelace, to the very present developments-is a prerequisite to understand and evaluate the social impact and ethical implications of the decisions faced by technologists.

Informal polls made in the classroom at the beginning of each course show that most students-usually in the third year in the university-are unaware of basic facts of the history of the technologies they study. They usually fail to place in time things like the invention of the modern digital computer or the Internet within a reasonable timeframe.

The approach to teaching the history of informatics is done through the following lenses:

- The situation of the society at a determinate moment in time, and the state of the art of the philosophical thought, science, and technology.
- The key inventions, when did they happen and what did they meant.
- The key individuals, studying the biographies of persons of interest in the story of informatics.

4.2. Updating the Social Impact, Environmental, and Ethical Dimension

The new ASMI course incorporates the following new points, in addition to most of the points of ISEPI. We only cite the new additions.

The first important point is "The acceleration of technological change and its effects." This is showcased with the study of the following aspects:

- The multiplier factor of ICT. A concept developed by Miquel Barceló to explain the impact a given technology has in the society [35].
- Moore's Law.
- Metcalfe's law.
- Law of Fracture [36].
- The future shock [37].
- The digital singularity [2].

To cover the "Social and economic aspects of ICT" we study the following concepts:

- 6 D's of Diamandis [38].
- IA, automation, and the future of work.
- Exponential organizations [39].
- Surveillance Capitalism [40].

Last but not least the sustainability impact of ICT is added addressing the issues of:

- The problem of e-waste.
- Green Computing.
- The UN Sustainable Development Goals [41,42].
- ICT as a possible asset for sustainable development.

4.3. Methodology in ASMI

The methodological approach authors follow is a mix of the ones discussed in the state of the art (Section 1.3) of this paper. To study ethics, we selected codes of ethics, case problems, the applied study of ethical theory, and whistleblowing as the key aspects. First, we provide a short 3 min video that illustrate why it is important to study ethics. Second in an expositive lecture session we explain ethical theories and how to apply them using examples.

The next session is a case study session in which students have to discuss in small teams (4–6 members) a case in which ICT have a key role and apply ethical theories to solve a moral dilemma. In another expositive session we explain the particularities of the profession and the basics of deontology. In the final session students are presented with a case study in which they again are divided in small teams. They have to apply a particular deontological code to answer a moral dilemma. Two more short videos are presented to students between the lectures. One explains a brief history of computer ethics and the other the basics of whistle blowing. To ensure that students watch these videos we use interactive videos in the university Moodle-based platform to ask them questions.

When teaching environmental and social aspects of technology the authors have combined traditional learning with active methodologies. Active methodologies refer to an umbrella term that encompasses a range of more learner-centered instructional methodologies such as collaborative and project-based learning [43].

There are many studies that argue that active methodologies are especially effective in engineering education [43–47]. In particular, in computer engineering education, there are examples of the use of active methodologies in different courses. In active methodologies, cooperative learning is a well-known technique. There are many different cooperative learning techniques [48].

Cooperative learning has proven to improve student's motivation and student's academic results. Students' perception of the quality of teaching and their academic results were significantly enhanced when compared with those students that were exposed to only one active methodology or none at all [49].

In particular, in ASMI, the authors have used several cooperative learning techniques described next:

Jigsaw. This technique is used to do a case study about the evaluation of a new technology. When evaluating new technologies several aspects (i.e., environmental, economic or legal issues) have to be considered. We selected a business analysis tool: the PESTLE o PESTEL method. PESTLE is a mnemonic which in its expanded form denotes P for Political, E for Economic, S for Social, T for Technological, L for Legal and E for Environmental. It gives a bird's eye view of the whole environment from many different angles that one wants to check and keep a track of while contemplating on a certain idea/plan [50].

We divide students in groups so that each group studies one aspect that can be affected by the new technology. After that, new groups are created. These groups include one person who has studied one particular aspect of the new technology (i.e environmental issues). In the end of the session, the final groups have one expert on each aspect of the technology they have to evaluate. They write a final report giving their evaluation. We have used successfully this technique in the classroom and online, by using the Moodle Forums with separate groups, during the COVID19 emergence. A case example is the analysis of the impact of a business of rental of electric scooter. The availability of internet devices has proven really useful, because the students can find out quickly about details relevant for the discussion. The following questions where formulated and researched by the students: What is the estimated lifetime of a scooter? What is the carbon footprint of the production and distribution of a scooter? What are the relevant regulations in our city regarding the case? And in other cities? Have been changes during the last years?

Think pair share. This technique is used when students have to answer questions about a topic previously discussed. Specifically use present students with 2–3 video sessions that present a situation related to one main topic. Examples of the videos used range from long form documentaries on topics like "planned obsolesce" [51], "startup culture", "emerging technologies" [52], movies or series episodes like "The imitation game" or Black Mirror's "Nosedive" disturbingly plausible episode about social credit [53].

After watching the video, the students are divided in small teams and presented a question about each video. Each student has to think about the question. After that each student shares his or her ideas with the other team members. Each team writes a report. The professor gathers the reports of each group and uses the answers to start a discussion with the rest of the class.

Group investigation. This technique is used to do a project that is carried out during the semester. Students are divided in 3-member teams. Each team chooses a topic from a list provided by the teachers. The team plans his investigation generating a list of research questions. This list is reviewed with the professors, who may offer suggestions of the approach to take, possible sources of information, etc. After the revision, each team carries out his investigation, and at the end of the semester each team performs a presentation in the classroom or records a video that is shown to the rest of the class. The teachers and the students evaluate each presentation.

Role playing debates in online forums. This is done by presenting an ethical dilemma based on a case. The key is to present a difficult situation where there is not a clear best course of action. The students will participate in a debate in an online forum hosted in the Moodle course. A group of 5–7 students will participate in a separate forum, and each student will have to defend a position assigned by the professor using arguments from a specific ethical theory.

All the assignments are delivered using the university e-learning Moodle-based platform. We chose this platform for our blended learning activities, a couple of years before it became the technology behind de UPC's Learning Management System.

In 2004 we started using a Wiki - hosted on the university e-learning platform- to perform some of the online learning activities. Using the wiki, the students can self-select the books they are going to read and the research project team they are going to be part of, by writing their names on a wiki page that presents the available options to them. This practice has proven to be really effective and save a lot of management time for the professor, and misunderstandings. The experience with the use of the wiki has been successful and 16 years later is still used in the course. The learning experiments contributed to the development of a set of didactical patterns to use the wiki in online and blended learning environments.

The wiki was also used in the past to allow online collaborative work in order to open the results of some tasks to the rest of their peers and the professors. The other students could see in the wiki their work and their progress. The professors could see the final result and also see the process of creation, being every action performed in the wiki available for review [54].

However, in 2012 we started noticing that the students shifted the use of the Moodle Wiki to Google Drive, according to the students this was because their familiarity with the platform, and its user friendlier interface. Today the wiki is still being used as the platform to choose assignments and group members, but the collaborative work is done on Google Drive.

5. Discussion

The ISEPI and ASMI courses have been in place for the last 29 years as optional courses in the UPC School of Informatics curriculum of Informatics Engineering.

Being an optional course, usually with students in their third or fourth year, most of the students pass the course with good grades and the fail rate is usually below 6%.

In every edition, all registration places have been sold out.; in the student satisfaction surveys, the course has averaged 4.2 over 5 of agreement with the key statement "Overall I am satisfied with this subject". In the last 5 years, with 257 students with a 53% participation manifested an agreement of 4.45 over 5 (see Figure 1).

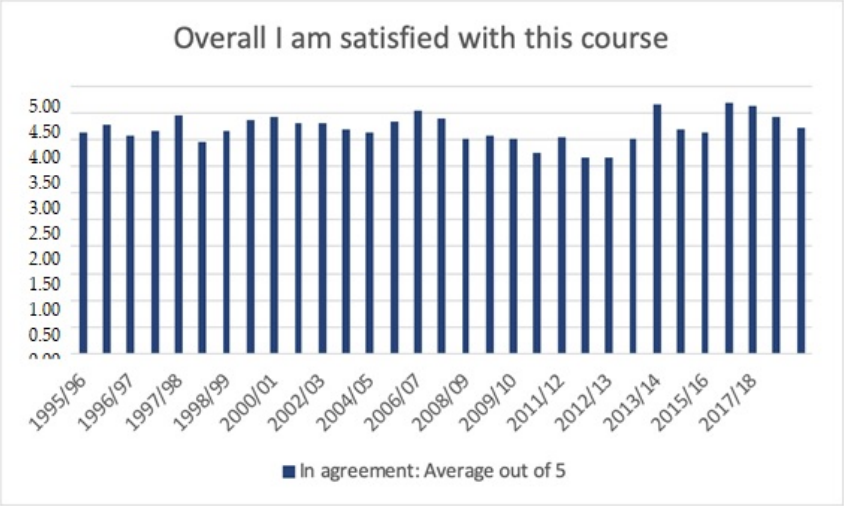

Figure 1. Average answers to survey of student satisfaction for the course over the last 15 years.

Over the years some students have volunteered some commentaries to complement the surveys. The majority of this commentaries are positive. Surprisingly variations of "I didn't expect the subject to be so interesting" and "This course should be mandatory" are repeated often. Another commentary we keep getting is: "This course has changed my view of the field of informatics" and "The subject has made me think a lot about aspects that had not crossed my mind". The students value are the combination of theoretical lectures with videos more connected with real world examples ("For me it has been very nice to attend classes because they are different every day, the combination between the theory of teachers and the videos of the subject is a success"), the diverse range of themes and issues discussed.

Feedback and clarity on the evaluate on criteria an aspect that the students usually ask for, and we try to improve. The students usually enjoy doing their presentations but are not fond with the presentations of the other students.

The authors agree with Johnson and Martin's argument about the particularities of ethics in the field of informatics: a mere training in philosophy and ethical theory is not enough, one needs detailed knowledge of the technologies and its implications. Nevertheless, any professor who wants to teach this discipline needs to work to improve their knowledge of philosophy, history, ethical theory, and other disciplines, like sociology, economy, and pedagogy.

The social and environmental aspects of computer science can be treated and studied in many ways. But in our opinion, it is important to work on aspects of the history of technology, linked to the history of ethical, scientific and philosophical thought, as well as a knowledge of the functioning of society - economics, politics, ecology.

Another important asset for teaching this course are the current events. During these years the news cycle has provided plenty of examples and cases to study. From the case of Napster to the whistleblowing of Edward Snowden, and scandal of Cambridge Analytica and the fake news. These cases have captured the interest of the students, providing a kind of root in the real world to what is discussed in class. Because ethics should not be a mere academic exercise.

An important part of the course is to have conversations and debates with the students. To achieve this is important to get the students to talk. Each professor has strategies to achieve this: asking questions to the group or particular students during lectures, using humor, discussing cases in the news relevant to the course, and specially carefully listening to the students when they speak, never dismissing their opinions as wrong but analyzing what they say and even ask the rest of the students about it.

When we have debates in class, we try to select points of view which differ from the mainstream opinion in the class and ask the proponents to expose their arguments. When we can't find division of

opinions, a viable strategy to get a good debate is for the professor to defend an opposing point of view using carefully provocation as a tool.

Last but not least, in the course "Economy, ethics and Information society" taught in the Informatics Engineering Degree in the Engineering School of Vilanova i la Geltrú, also at UPC, there has been a big success in a project-based learning experience. Coached by the professor the students have been collaborating with social projects, as part of the course activities. This experience has proven to be really valuable to teach ethics, social and environmental values through real life experiences. However, this experience has only been conducted with small class groups up to 22 students, we have to find out a way to scale the experience to groups of 50+ students.

6. Conclusions

At the Barcelona School of Informatics, "Sustainability and social commitment" has become a transversal competence worked on in various subjects, while the aspects related to ethics and the history of ICT are only found in ASMI. An optional subject that only 50 students can take each year, compared to the 200 that graduated in 2017.

Each new curriculum puts more emphasis on technical specialization, increasingly specific to specific topics, and humanistic aspects are virtually absent in the studies. This hyper-specialization, the absence of the humanities, and the treatment of the aspects of social responsibility of engineers as an optional subject is a mistake and causes a lack in the training of future engineers.

We aim to pass on our experience to the network of universities weaved withing the EU UNITE project, a which is committed to ethical, safe, and sustainable technology that generates solutions to societal challenges [53–56].

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