# Didactics of Computer Ethics: A Literature Overview

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## Abstract

New and, in a certain degree unforeseen, moral issues arise from the digital revolution. Computer ethics is the field that studies the concerns about the impact of Information and Communication Technology (ICT) in the modern society. Computer ethics has known an explosive development in the last two decades and its future prospects appear to be stable and considerable. Given that personal, social, and professional life increasingly depend on ICT, academic information technology studies curricula give more and more emphasis on computer ethics teaching. Computer ethics didactics is a new and, due to the nature of the treated topics, novel field. In this study, we attempt to investigate the published articles dealing with computer ethics didactics, in order to clarify and present the corresponding arguments. This argumentation and experience may prove useful when dealing with computer ethics in secondary education. We discuss the main topics treated in published articles: the need for computer ethics didactics and the related educational goals and content, the question about the most appropriate instructor, ways of integrating the course to the curriculum, educational methods, and utilization of ICT in ethics didactics and evaluation of student efforts.

## 1. Introduction

The term "computer ethics" appeared in the mid 1970s, and it was used to define the field that examines "ethical problems aggravated, transformed or created by computer technology" (Maner, 1980, as cited in Bynum, 2001b, p. 110). New definitions were added in the 1980s. Computer ethics is the field that studies the way computers "pose new versions of standard moral problems and moral dilemmas, exacerbating the old problems, and forcing us to apply ordinary moral norms in uncharted realms" (Johnson, 1985, p. 1). Computer ethics "is the analysis of the nature and social impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology" (Moor, 1985, p. 266). This last definition proved to be the most influential until now. A different approach concerning the importance that should be attributed to the term "computer ethics" was added in the 1990s. Computer ethics "should be viewed as a branch of professional ethics, which is concerned primarily with standards of practice and codes of conduct of computing professionals" (based on the argumentation in Gotterbarn, 1991, Bynum, 2001a, p. 1).

Since the 1990s, computer ethics has been developing rapidly thanks to the establishment of research institutions, the organization of congresses, the publication of a large amount of articles and books, and the engagement of further researchers with this subject. Today, there is a number of philosophical approaches regarding the function and importance of computer ethics. According to the no resolution approach, computer ethics does not exist as a distinct scientific field and it does not have a conceptual foundation. The professional approach suggests that computer ethics is a pedagogic methodology, which is indistinguishable from other applied ethics, such as medical ethics or engineering ethics, with the exception of its pedagogic context. According to the radical approach, computer ethics deals with absolutely unique subjects and constitutes a distinct scientific discipline. The conservative approach argues that computer ethics may very well be studied in the context of classic ethics (e.g., consequentialism, deontologism, virtue ethics, contractualism), and that moral issues transformed through Information and Communication Technology (ICT) use represent nothing but new forms of traditional moral issues, to which already available moral theories may successfully apply (Floridi & Sanders, 2000).

As in any similar human attempt, there are disputes concerning the importance of computer ethics and the issues covered, but for all that a relative progress has been made. If we confidingly treat computer ethics as a routine issue, or even worse, as an unsolved issue, then ICT could occasionally turn into a potential threat to us (Agarwal & Garcia, 2006). Computer ethics handles subjects, such as computers in the workplace, computer crime, privacy, intellectual property, professional responsibility, globalization, legal issues and social responsibilities and the right to access (Bynum, 2001a).

## 2. The Need for Computer Ethics Didactics

Argumentation about computer ethics didactics focuses on the framework of its university implementation, especially in Computer Science departments. Such research may prove to be useful where trying to address computer ethics in secondary education as well. In the evolving information society, the moral development of secondary education students takes place in the context of ICT use in school and at home. Students start making decisions and choices that

require the implementation of ethical judgments at an early age by experimenting with the use of ICT. A typical example is exploring the virtual world of the Internet, with which parents and teachers may not be adequately familiar. We should encourage children to develop moral attitudes that will lead their choices in the modern and future information society (Meyenn, 2000).

The main difficulty regarding the integration of computer ethics into the computer science curriculum arises from the idea that computer ethics has no place in information technology studies, because it does not constitute a part of conventional computer science (Appel, 1998). However, there are several arguments emphasizing the need to integrate computer ethics to the informatics curriculum. The intervention of computers in human behavior creates totally new moral issues that are unknown to other fields, or transforms existing moral issues to such a degree that they deserve separate study in their radically unique form (Maner, 1996). Computer technology modifies human action and allows individuals and organizations to behave in ways that would be impossible without this technology (Johnson, 2001). The development and implementation of new information technologies often outruns our ability to recognize the moral and social impact of their use. It is possible that ICT professionals would not agree to a common conduct (Schwartz, 2005). ICT professionals are involved in the analysis, design, development, delivery, management, and use of Information and ICT in organizations and society, while playing a central role in the implementation and integration of new technologies to social and professional life (Harmon & Huff, 2000). ICT professionals are often confronted with questions that demand evaluation and are impossible to answer in exact mathematical terms (Huff & Martin, 1995). The inherent property of ICT to cross physical and cultural borders makes it more and more difficult for us to apply acceptable laws, regulations, and codes of conduct (Barnard et al., 2001).

It is important to draw the attention of computer science students to the moral implications of ICT development, since its implementation involves large user groups and influences immensely their personal and professional interests (Zlatarova, 2004). Future ICT professionals should not automatically accept professional traditions, but rather practice critical appreciation and proceed to potentially required changes. Students are aware of computer ethics issues thanks to their everyday experience (Owens, 2005). They must know that a reevaluation or reconstitution of their professional field might become essential in the future. The integration of computer ethics in the curriculum prepares students for ethical professional decision making. It encourages and arms them with methods of analyzing the moral implications of designing and implementing new information systems. It offers them considerable opportunities to get involved in critical thinking about the impact of ICT to society and about the human side of technology (Appel, 1998).

In addition, there are two different positions regarding the need to include computer ethics didactics in informatics studies curriculums: the educational and the pragmatic answer (Stahl et al., 2004). Given the existence of computer ethics issues, the educational approach stresses the fact that exposure to such issues must be a part of the students' learning experience in the context of the enlightening and emancipating character of education (Dawson & Newman 2002, as cited in Stahl et al., 2004; Settle & Berthiaume 2002). The pragmatic approach suggests that the so called "soft skills" are essential in the working environment (Noll & Wilkins 2002, as cited in Stahl et al., 2004) and their fulfillment increases the chances of employment for graduates (Rahanu et al., 2002 as cited in Stahl et al., 2004).

The phrasing included in the Computing Curricula 2001 report, is often quoted in published articles (The Joint Task Force on Computing Curricula, 2001, p. 141):

> Undergraduates also need to understand the basic cultural, social, legal, and ethical issues inherent in the discipline of computing.…Students also need to develop the ability to ask serious questions about the social impact of computing….Future practitioners must be able to anticipate the impact of introducing a given product into a given environment.…Finally, students need to be aware of the basic legal rights of software and hardware vendors and users…Future practitioners…must understand their own limitations as well as the limitations of their tools.

## 2.1 Educational Goals

The goal of computer ethics teaching is to make students aware of moral issues concerning the development and implementation of ICT and help them to comprehend how ITC influences social environments (Johnson, 1994). Students should be in position to isolate and bring out these issues, and to develop critical appreciation and analyzing skills in situations that demand ethical decision making (Fisher & Abunawass, 1994; Johnson, 1994; Moskal et al., 2002), in order to choose the best alternative action and respond more effectively when faced with difficult problems (Botting, 2005). They should be in position to argue in favor of and rationalize their professional decisions (Moskal et al., 2002), as well as to bear their respective responsibilities as ICT professionals (Wahl, 1999). Another goal is to encourage students to form, express, and defend their own views concerning the social, legal, and moral implications of ICT (Wahl, 1999).

However, what is right or wrong cannot be taught. Philosophy professors acknowledge that it is difficult, even impossible, to teach someone ethics (Martin & Weltz, 1999). This is a much more complex work that involves advancing students' sense of moral development and

reasoning. The goal should be the creation of an environment that allows students to call safely in question and reflect on their moral convictions that relate to their professional future. Students must be able to share the point of view of ICT users, and put into words users' questions concerning the importance and operation of a new technology in the way users themselves would put them (Nussbaum, 1997, as cited in Dark & Winstead, 2005). Students must comprehend the impact of ICT on the nature of social relations, and wish to participate in the political dialog with an attitude that focuses in a common social future (Dark & Winstead, 2005).

### 2.2 Content

Main sections that must be treated in a computer ethics class are presented in many studies with only few variations. The content can be organized into 10 learning units: history of computing, social context of computing, methods and tools of analysis, professional and ethical responsibilities, risks and liabilities of safety-critical systems, intellectual property, privacy and civil liberties, computer crime, economic issues in computing, Philosophical frameworks of ethics (IEEE-CS/ACM Joint Task Force on Computing Curricula, see http://www.sigcse.org/cc2001/SP.html ). The content may be organized into five learning sections: responsibility of the computer professional, basic elements of ethical analysis, basic skills of ethical analysis, basic elements of social analysis, and basic skills of social analysis (ImpactCS Project at George Washington University, see http://www.seas.gwu.edu/~impactcs/). Another proposal includes the following sections: computer crime and computer security, software theft, and intellectual property rights, computer hacking, and the creation of viruses, computer and information systems failure, invasion of privacy, social implications of artificial intelligence and expert systems, and workplace computerization (Forester & Morrison, 1994).

The theory of ethics is proposed as an essential part of computer ethics didactics, because it offers the necessary outline for ethical analysis and decision making. The theory of ethics encourages students to develop a personal moral context and offers a healthy fundament, so that they will be able make ethical decisions and defend them in their personal or/and professional environment (Staehr, 2002). By nature, codes of conduct offer merely general guidelines and serve multiple goals, given that they are written to address three main audiences: the professional, the employer or the customer, and the public. A code of conduct does not supply specific guidelines regarding the ranking of those groups in a certain situation (Martin & Schinzinger, 1995 as cited in Staehr, 2002). On the other hand, it is suggested that philosophical ethics is a huge field and that most computer science students are unfamiliar with the subject or have little experience of it. At the same time, the lack of a coherent ethical system poses another problem. In the modern multi-cultural society, we cannot assume that students have a homogenous understanding of various moral questions. It is indeed claimed that the opposite is true (Stahl et al., 2004).

## 3. Who Should Teach Computer Ethics

Published articles are often concerned with the question who might be the most appropriate computer ethics instructor. Two main views are registered: the first one claims that computer ethics should be taught by philosophers or social scientists, while the second one claims that it should be taught by computer science specialists (Barnard, et al. 2001).

Computer ethics is by nature an interdisciplinary field containing elements both of philosophy and social sciences and informatics science (Barnard, et al. 2001; Martin, 1997). Advocates of leaving the teaching of computer ethics to philosophers and social scientists claim that computer ethics topics are basically moral, social and professional. Philosophers and social scientists have the skills required to analyze the respective arguments, to meticulously study assumptions and implications, to use appropriate conceptual contexts, to examine situations, to evaluate and substantiate courses of action, and to observe and analyze human behavior, while information technology scientists do not possess similar experience and specialized education (Johnson, 1994).

However, the opposite view, suggesting that computer ethics should be taught by informatics professionals is predominant both in article publications and in practical implementation. According to this logic, philosophers appreciate moral issues in depth, but they do not have adequate knowledge of high technology issues (Gotterbarn & Miller, 2004). It is more appropriate that computer ethics topics are presented by a computer science specialist, in order to highlight them, convince the students of their importance, and eliminate the danger of dealing with computer ethics as a subject that is rather irrelevant to information technology science (Johnson, 1994; Gotterbarn, 1992). In addition, computer scientists may get training in ethical theories, since we all practice moral evaluation in our everyday life (Maner, 1994). Moral philosophy requires deep understanding and involvement. However, the practical ethical applications required in computer ethics may be separated from philosophy and its theoretical complexity may be ignored to a large extent (Gotterbarn, 1992). Moreover, it is claimed that when the computer ethics field is established as mainstream computer science, it will be taught and studied just like the rest of the Information Science fields, and the question concerning the appropriate teachers will be void (Barnard et al., 2003).

A third proposal that was not widely implemented for practical reasons is to assign computer didactics to a group consisting of informatics, philosophy, and social sciences

instructors, or organize lectures by visiting professors of the above fields (Dunlop, 1994; Martin, 1994).

## 4. Integration into the Curriculum

Three basic approaches regarding the way computer ethics can be integrated into the informatics curriculum are discussed in the published articles. a) The establishment of distinct courses in computer ethics (single-course or stand alone courses), b) the implementation of capstone courses, and c) the integration of educational sections into the basic computer science courses ("integrated approach" or "ethics across the curriculum") (Gotterbarn, 1999).

Computer ethics is taught as a distinct course or as capstone courses in many schools. The approach of one course functions as a good introduction to computer ethics and makes sure that students in different universities gain similar experiences. Further, it assigns teaching ethics to few instructors, obviously those who have more qualifications to bring it off, or at least those who feel more comfortable with the subject. It is claimed that the course should be taught in the last years of studies and deal with advanced topics, since, when it takes place in the beginning, students lack the required ICT experience (Califf & Goodwin, 2005). However, including computer ethics in an Information curriculum in such a manner may possibly give students the impression that it is an issue of minor importance, disconnected from the computer science. The presentation of moral and social issues not directly connected to the development of new technologies could give the students the impression that Information technology (architecture, algorithms, networks etc.) is not related to the consequences arising from its implementation (Califf & Goodwin, 2005; Ghafarian, 2002). This could reduce the desirability of computer ethics for the students (Weltz, 1998). The ethics across the curriculum approach attempts to avoid the isolation of moral issues from the technical ones. When the discussion of moral issues regarding technology implementation takes place where the relative course is held, then computer ethics becomes meaningful and applicable to real situations that students are bound to face. This way, students can appreciate computer ethics as an integrated informatics field. The integrated approach may introduce students to ethical challenge resolution at an early stage and enhance their perception in the course of their undergraduate studies (Califf & Goodwin, 2005; Weltz, 1998). The integration of ethics into computer science courses requires more than a redistribution of capstone or single course to other courses, and it should not take place by merely adding text for reading. A short introduction to computer ethics is not enough. Tough questions should be asked by the last year of studies, and students should be encouraged to produce their own answers in the same way that they will be asked to as professionals in the real world (Weltz, 1998).

However, by implementing the "ethics across the curriculum" approach, computer ethics might be treated as an attachment to specialty courses, and instructors could leave them for the last days of the course, provided there is enough spare time (Gotterbarn, 1999), or even leave them out completely (Califf & Goodwin, 2005). Students could possibly think that ethics is merely included in order to fulfill the minimum requirements of the curriculum and they could fail to comprehend their specific professional obligations. Moral issues discussed in an informatics course should associate directly with and arise naturally from the technical content. The ethics across the curriculum approach may function well, provided there are enough school members that commit to teaching computer ethics in computer science courses (Gotterbarn, 1999). The integrated approach requires efforts on behalf of the curriculum team, in order to ensure that all computer ethics knowledge units are covered in adequate depth. It is essential to ensure that students realize the connection between computer ethics and specialty courses of the curriculum (Martin et al., 1996). Without careful design, the instructor takes full responsibility for the modules, and students might deal with the same computer ethics issue more than once during their studies, or different computer ethics issues might be taught in each university (Califf & Goodwin, 2005).

All the above approaches concerning the integration of computer ethics into the computer science curriculum are not definite or mutually exclusive. As proposed, it is best to implement a combination of strategies: a series of compulsory computer ethics courses combined with the integration of appropriate teaching material into other courses (Martin et al., 1996).

## 5. Educational Methods

Computer ethics is not a technical learning subject and teaching it with traditional educational methods is difficult. The nature of computer ethics requires a student-centered educational method that actively involves students in the learning process. Students should have opportunities to experience, interact, present, and develop their internal values, adjust their behavior voluntarily and develop a new, autonomous moral personality based on their own beliefs. A student-oriented educational method offers all students the opportunity to exercise "their voice…know, care and act" (Dark & Winstead, 2005, p. 30), while creating a context of mutual respect, where might and power are distributed fairly between students and instructors (DeVries, 1998, as cited in Dark & Winstead, 2005). Implementing student-oriented educational methods in computer ethics didactics allows us to focus on the study of technology as a factor that perpetually transforms human experience, while students can familiarize themselves with ethical philosophy or professional codes of conduct and manage to act in a competent, moral, logical and responsible way (Corey, 2001). The development of a personal attitude studied by

means of active experimentation and respective experiences benefits students in their professional course of life (Dark & Winstead, 2005).

Published articles often emphasize the implementation of case studies as a basic pedagogic tool in computer ethics didactics. The case didactics method combines four characteristics: situational analysis, active student involvement, non-traditional instructor role, and the need to relate analysis and action (Christensen and Hansen, 1981, as cited in Martin & Weltz, 1999). Case studies emphasize collaborative, student-centered education. Problems usually arising in case studies are ill structured, while the data is integrated to the problem itself and emerges during the study of the problem (Ghafarian, 2002). Case studies are effective ways of involving students in problem solving activities. They contribute to the development of critical reasoning and analytical skills, while increasing student awareness of moral and social questioning (Gotterbarn & Riser, 1997). It is very important for students to practice their moral decision making skills and to develop a context that they will follow in the real business world (Mai-Dalton, 1987, as cited in Martin & Weltz, 1999).

The “case” is defined as a factitious scenario or a real account (Pierce & Henry, 1996) that presents some moral dilemma arising from ICT implementation. It is essential to select an appropriate scenario that achieves specific educational goals or/and implements particular didactic sections. There are at least two criteria for the selection of scenarios: the ethical/legal nature of the situation described in the scenario and the content or subject of the scenario (privacy, copyrights, etc.). Regarding the nature of the situation described in the scenario, there are four eventual combinations: it may be ethical and legal, ethical but not legal, not ethical but legal, not ethical and not legal (Kallman & Grillo, 1993 as cited in Benbunan-Fich, 1998). The case study is put to practice by means of scenario analysis, aiming to the selection and substantiation of the appropriate action for the involved person. Analysis methods are applied, which define a series of steps for the selection of the best course of action among other alternatives. Some scenario analysis methods proposed in the published articles are the worksheet (Gotterbarn & Riser, 1997), the criteria (Benbunan-Fich, 1998), the environmental algorithm (Pierce & Henry, 1996), the parallel space methodology (Morris, 1999), and the ethical case assignment (Staehr, 2002).

Indicatively, the worksheet for ethical decision making comprises of the following steps (Kallrnan & Grillo, 1993, as it appears in Maner, 1999).

1. What is the ethical issue or problem?
2. What immediate facts have the most bearing on the ethical decision you must render in this case?
3. Who are the claimants in this issue and in what way are you obliged to each of them?
4. What do you think each of these claimants would prefer that you do regarding this issue?
5. List at least 3 alternative courses of action.
6. Are any of your alternatives supported or rejected by ethical guidelines?
7. Determine a course of action based on your analysis
8. Defend your decision in the form of a letter addressed to your most adamant detractor. (p. 8)

The environmental algorithm includes the following steps (Pierce & Henry, 1996):

1. Define the "context and ethical issues”.
2. Consider relevant facts and perspectives related to the context and issues
3. Define alternative strategies (Think creatively!) using all input from expectations and consequences of:

Personal Attitude Influences:
- Ethical Theories
- Professional Expectations
- Laws
- Company Codes, Rules
- Other (family values, etc.)

Contextual Norm Influences:
- Stakeholders (users of the product, clients, etc.)
- Peers
- Supervisors
- Organizational Culture
- Society

4. Consider each alternative based upon Personal Attitude Influences (See #3 above.) and Contextual Norm Influences (See #3 above.) placing weights on each component.
5. Select an intended or recommended course of action which is defensible, weighing the influences and consequences of Personal Attitude Influences and Contextual Norm Influences. (p. 52)

Besides, moral dilemmas may be analyzed according to ethical operational frameworks, e.g., utilitarian (ethical decisions are made on the basis of maximization of happiness), deontological (ethical decisions are made on the basis of the application of righteousness), virtuous (ethical decisions are made on the basis of individual character), relativist (ethical decisions are made on the basis of personally defined truth, in the absence of any belief in universality). This additional aspect-approach does not require emphatic connection with the philosophical theory of ethics (Greening et al., 2004).

Another suggestion is case based analysis. This is a “bottom-up” approach for ethical decision-making. Given a specific control case, the first step is to identify similar examples that clearly reconstruct right and wrong activities. The study of examples brings into light the respective

characteristics that substantiate the evaluation of the action as right or wrong. The moral quality of the case is determined by comparing the example characteristics with the case characteristics. Case based analysis is different than case study. By comparing a control case with example cases, students come to notice "gray shades" in many realistic situations and may realize how some aspects of a moral dilemma could involve principles, others could relate to impacts and others could refer to virtues. It is suggested that case based analysis may apply mainstream moral theories to ethical decision making (Quinn, 2006).

In addition, discussion is proposed as another educational technique in computer ethics didactics. Discussion allows students to deal directly and quickly with multiple perspectives and unstated assumptions in various collocations. The technique of discussion in class carries some obstacles and computer science instructors are usually not familiar with methods of eliminating them. Such methods are safe and objective evaluation of the students' efforts, class control and management, making sure that all students participate in the discussion, verification of academic style and coherence of the discussion with the initial subject, encouragement and ensuring that all students are adequately prepared for the class – the course (Sanders, 2005).

Furthermore, in an attempt to eliminate the classroom environment stereotype and promote new ideas and attractive educational actions concerning computer ethics issues presented to the students, researchers propose the use of out of class activities. Some basic ideas regarding out of class activities are: organization of an undergraduate research-oriented seminar, development of projects related to college committee activities, design and maintenance of an information board for students majoring in informatics, organization of quiz bowls, field trips to leading in the introduction of information technology in their business companies, presentations in front of the faculty, forum auditorium on-campus, and involving students in the conference organization (Zlatarova, 2004).

Researchers also suggest the use of contemporary media, e.g., videos and films. The concept is to take advantage of the intense interest students show in contemporary media, and bypass the conclusion that encouraging informatics students to write anything but computer programs is a tough challenge (Applin, 2006). A media production often offers the opportunity to approach more than one topic simultaneously in a dramatic setting, while highlighting the coherence and completeness of computer ethics topics. Using media in the classroom may involve showing an episode to students, discussing the episode in the class, showing its explanation to students, discussing the explanation in the class, and assigning a paper on the basis of the clip and discussions (Yamanoue et al., 2005). Some basic issues concerning the use of contemporary media are time restrictions and cost (Applin, 2006). There are Web sites offering compilations of contemporary media resources, such as these sites: http://www.ithaca.edu/faculty/aapplin/ethicsmedia.shtml or http://www.cse.nd.edu/~kwb/nsf-ufe/video-reviews.html.

## 6. Use of ICT in Computer Ethics Didactics

Basic ICT infrastructures and services are implemented in computer ethics didactics: Web use for content uploading, local network and Internet use for online education, educational application development, collaborative learning and active learning.

The goal of the Web sites is to provide support for instructors or/and students of computer ethics. The sites include moral dilemma scenarios, moral scenario analyzing tools, and sources about computer ethics that may prove useful in didactics. For example, ComputingCases.org (http://computingcases.org/) includes historical cases in computing ethics, sets of classroom exercises and assignments, essays about teaching computer ethics with cases, advice about constructing grading rubrics, background information about the recommended computer ethics curricula, an introduction to socio-technical analysis, and guidance in using socio-technical analysis. The Online Ethics Center at the National Academy of Engineering site (http://www.onlineethics.diamax.com/) addresses the professional responsibilities of computer scientists and software designers and contains teaching advice, research, and pedagogical information regarding the integration of ethics into the classroom. The Online Ethics Center for Engineering and Science at Case Western Reserve University site (http://temp.onlineethics.org/), in the Computers and Software link contains cases, discussions, and ethical guidelines bearing on the professional responsibilities of computer scientists, computer engineers, and software designers and engineers. Interactive Computer Ethics Explorer is an online questionnaire about computer ethics:
http://web.cs.bgsu.edu/maner/xxicee/html/welcome.htm.

Informatics students are familiar with electronic communications and they usually have access to networked computers. At the same time, demand for computer ethics courses may increase, while the number of specialized instructors does not (Miller, 1999). Local networks and the Internet are used as infrastructures for holding computer ethics courses or as a mean of running educational applications (e.g., Blackboard) that guide students through the decision making process concerning moral dilemmas. It is proposed that students should be encouraged to take advantage of asynchronous communications and receive help in gaining a notion of the on-line community. The course should be structured in a way that utilizes the students' curiosity about the study of computer ethics issues

and the relative Web facilities (Miller, 1999). The experience of holding computer ethics courses in Web environment is encouraging, while students with very different learning experiences should learn skills that can be implemented in the working environment and gain better understanding of ICT impact to society, of the types of ethical issues they may face in their work environment and of their responsibilities as ICT professionals (Coldwell, 2000).

Educational applications with Web infrastructures attempt to create an interactive Internet environment that oversteps a passive information system, in which students try to locate data and implement them in the context of a scenario analysis (Lee, 1999). Students are often overawed by the amount of study required and the learning environment should be handy and appear "seamless" to students (Goold & Coldwell, 2005, p. 236). Applications implement case studies and offer support tools for scenario analysis and ethical decision making. The student receives help in analyzing a moral dilemma case in a guided and gradual way (Goldin et al., 2001) or using consultative content that is available any time (Robbins et al., 2004). According to the first approach, the student cannot advance to the next step without having concluded the previous one. However, he/she may back up any time, review his/her previous answers, and compare them to the answers of his/her peers (Goldin et al., 2001). In the second approach, the goal is to develop an automated tool, which intervenes in real time and guides the student, helping him/her to comprehend his/her own ethics (Robbins et al., 2004). The consultative content may include basic ethical philosophy elements or codes of conduct. It is suggested that participants using such an environment are in position to determine the main moral issue of each case more often than those not using it (Robbins et al., 2004).

In addition, ICT is used as a valued and significant infrastructure that encourages students to actively participate in learning procedures (Polack-Wahl, 2001), enhances activities and incentives, stimulates cooperation among students, and is concluded with a face to face communication (Jefferies et al., 2003). Collaborative learning makes knowledge more realistic, and asynchronous learning technology tools offer students a larger amount of choices during processing and reflecting on information (Veerman & Veldhuis-Diermanse, 2001, as cited in Griffin & Grodzinsky, 2002)**.** Collaborative learning supported by educational technology may result to deeper comprehension (Mäkitalo et al., 2001, as cited in Griffin & Grodzinsky, 2002). Moral dilemmas encourage group discussions, and group work produces better solutions to moral and ethical problems compared to individual pursuit (Peek et al., 1994, as cited in Griffin & Grodzinsky, 2002), better learning and more advanced learning skills (Hiltz, 1994; Saloman & Globerson, 1989, as cited in Jefferies et al., 2003). It is proposed that, since moral judgments are a social construction, the development of a personal moral code is facilitated in a group situation (Mäkitalo et al., 2001). Emphasis is laid to group/peer learning, to focusing in the collaborative implementation of theoretical knowledge (ethical philosophy, professional codes of conduct) and to the extensive use of discussion (Robbins et al., 2004). Students are asked to develop research and evaluation skills and produce collaborative reports based on research and discussion (Jefferies et al., 2003). Among others, the implementation of a learning environment that is based on technology seems to succeed in eliminating student misgivings about education in non-technological subjects (Mancherjee & Sodan, 2004). Only a small amount of empirical research concerning the educational results of collaborative learning by means of ICT in computer ethics didactics is available. Existing research ascertains positive results, with students occupying themselves more intensively with the subject compared to traditional environments, and improving their performance. Problems concern mostly the reliability of technological infrastructure and the respective difficulties (Griffin & Grodzinsky, 2002).

## 7. Student Evaluation

In a subject such as computer ethics, it is important to keep in mind that students must be evaluated according to their knowledge and skills, not according to their values or beliefs (Sindelar et al., 2003). Several evaluation methods are proposed, e.g., writing of position papers that will be presented in the classroom, or even more informal approaches including peer and teacher review methods, discussion in the classroom, and didactic sessions.

Papers require that students, individually or in groups, analyze a moral dilemma scenario. Students are evaluated based on their ability to reveal all aspects of a question and argue in this respect (Houle & Simon, 1996). Scoring rubrics are proposed, which apply specific criteria in order to ensure objective work evaluation and allow both the instructor and the students to track changes in their performance in the course of time (see Moskal et al., 2002). There are also approaches that use a scenario evaluation worksheet, thanks to which students know what they are expected to do, while a set of specifically defined guidelines for paper evaluation is available to the instructor, facilitating their work (Goold & Coldwell, 2005). Moreover, the use of a criteria scale is proposed for paper evaluation, such as the "7-Cs" scale of correctness, cogency, completeness, conciseness, clarity, concreteness, and creativity (Sanders, 2005). It is said that the variety of evaluation methods is limited merely by the creativity of instructors and the available time (Barnard et al., 2001).

Table 1. An indicative example of scenario analysis evaluation (Gotterbarn & Riser, 1997, p. 14)

| % | Scenario Analysis Evaluation |
|---|---|
| 15 | writing (grammar, spelling, punctuation, reference formats, and general clarity) |
| 15 | identifies stakeholders, stakes, responsibilities of the computer professional(s) involved with respect to each stakeholder |
| 10 | isolates the ethical issues involved |
| 10 | identifies relevant principles of the ACM Code of Ethics and Professional Conduct |
| 15 | discusses various courses of action, including alternatives in addition to the obvious extreme positions |
| 20 | recommends and justifies course of action |
| 15 | offers suggestions for preventing a recurrence (e.g. policy changes) and discusses immediate and long-term consequences |

encouraging and agrees that there is a change in students reflecting on computer ethics issues, gaining more and more knowledge and deeper understanding, increasingly worrying about moral issues and realizing their importance in the working environment (Gerhardt, 2001; Houle & Simon, 1996). Computer ethics didactics has a useful influence to the moral development of students (Byrne & Staehr, 2004). The research results indicate that computer ethics didactics may achieve its goals. However, further work is needed in order to draw safe conclusions, since there is no established causal nexus between computer ethics didactics and moral development (Staehr & Byrne, 2003). Finally, there is evidence that the skills gained from computer ethics didactics may be implemented to other moral situations that are irrelevant to ICT use (Owens, 2005).

## 8. Conclusion

Published articles intensely emphasize the importance of computer ethics didactics and examine the basic axes concerning its implementation-materialization. Computer ethics didactics faces some difficulties regarding the wide range of specific issues discussed and the absence of a certain technical flavor that is typical for computer science learning units, and that students know and evaluate as important. The nature of computer ethics encumbers the investigation of learning results and further research efforts are necessary. The progress of ethical beliefs in humans is by nature an internal and complex process. It is difficult to determine whether students possess certain characteristics before or after computer ethics education. We have to explore which aspects of the changes in students' attitudes and behavior are cognitive, sentimental or social (Dark & Winstead, 2005). For the time being, only few universities consider computer ethics didactics as an essential part of their curriculum, and computer ethics is often a product of personal initiatives rather than a general university policy (Todd et al., 2001). We hope that this paper provides a precise picture of the research done in computer ethics didactics and that it could prove useful as an overview or a starting point for the instructor that engages in or attempts to engage in the difficult task of computer ethics instruction in academic or precollege education.

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