The case for integrating ethical and social impact into the computer science curriculum

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1 Introduction

I invite all of you to join me on the "high moral frontier" of computer science as we consider the case for integrating ethical and social impact issues into the computer science curriculum. I have to warn you, however, that there tends to be a lot of crossfire on this new frontier! In this paper I will develop the rationale for curricula change and then I will present a case study of a recent issue, content labeling and blocking on the Internet, as a compelling example to illustrate why this change is necessary.

Computer science as a pedagogical discipline has advanced rapidly in the last several decades, and this advance necessitates the continual revision of the curriculum for an evolving discipline. One of the fundamental changes in computer science in the last decade has been the realization that the context in which technology is used must be taken into account in its design, partly because of the ethical implications of its use and partly because understanding the context of use helps inform and improve the design [3, 17, 19, 25]. This recognition is included as one of the foundational principles in *Computing Curricula 1991* (CC91) [1, 29], and has been a part of curriculum standards for almost a decade [1, 5].

CC91 was developed by a joint task force of the ACM and the IEEE Computer Society and provides an elegant framework for the current iteration of the computer science curriculum. It provided a definition for the discipline of computer science as a hybrid of mathematics, science and engineering [29]. It also provides a new definition for computer science education in terms of three processes, nine fundamental subject areas, twelve recurring concepts that cut across the subject areas, and a social and professional context. The three processes of computer science are *theory*, derived from its mathematical roots, *abstraction*, derived from its scientific roots, and *design*, derived from its engineering roots. The nine fundamental subject areas are algorithms and data structures, architecture, artificial intelligence and robotics, database and information retrieval, human-computer communication, numerical and symbolic computations, operating systems, programming languages, and software methodology and engineering. The twelve recurring concepts are binding, complexity of large problems, conceptual and formal models, consistency and completeness, efficiency, evolution, levels of abstraction, ordering in space, ordering in time, reuse, security, and tradeoffs and consequences.

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Significantly, the area of social, ethical and professional issues is not defined as a separate subject area, but as a context within which the rest of the curriculum would sit. It includes the historical and social context of computing, responsibilities of the computing professional, risk and reliability, and issues related to intellectual property. Of the twelve recurring concepts that cut across the content areas of computer science, six of them (reuse, security, tradeoffs and consequences, evolution, complexity of large problems, and consistency and completeness) are intimately linked to an awareness of the social context in which technology is used and are informed by a social scientific analysis of computing. In CC91, understanding the social and ethical context of computing is considered central to the knowledge needed by a qualified graduate of a computer science program:

> Undergraduates need to understand the basic cultural, social, legal, and ethical issues inherent in the discipline of computing. They should understand where the discipline has been, where it is, and where it is heading. They should understand their individual roles in this process, as well as appreciate the philosophical questions, technical problems, and aesthetic values that play an important part in the development of the discipline. … Students also need to develop the ability to ask serious questions about social impact and to evaluate proposed answers to those questions. Future practitioners must be able to anticipate the impact of … a given product. Will that product enhance or degrade the quality of life? What will the impact be upon individuals, groups, and institutions? [1, p.11]

2 ImpactCS project

However, CC91 fell short in providing sufficient detail and guidelines about how to do this. To address this need the ImpactCS Project was funded in 1994 by the National Science Foundation [30]. It brought together 25 experts from the area of computing ethics and social impact to define the core content and methodology for integrating social impact and ethics topics across the computer science curriculum. Over the course of three years the project has addressed major problems that hamper the implementation of across-the-board curricular change: the lack of a well-specified definition of core content and learning objectives, and the lack of a strategy for adapting and adopting existing materials that address the core topics into the computer science curriculum. To date, two reports have been disseminated nationally [18, 23] and a third is currently being written.

2.1 A conceptual framework

It is clear that the study of ethical and social issues in computing is interdisciplinary in nature. The conceptual approach integrates, from the perspective of computer science, the complementary disciplines of philosophical ethics and social science. Ethicists from both philosophy and theology, historians, social analysts, sociologists, anthropologists, and psychologists have all contributed heavily to the research in this area [3]. However, instead of requiring computer science students to learn from these disciplines by taking separate courses in philosophy and sociology, we propose that elements from these disciplines be incorporated into the core of computer science.

"Technologies cannot be divorced from a social framework. Computer scientists need to be educated to understand some of the complex linkages between the social and the technical … computer science education should not drive a wedge between the social and the technical" [12, p. 69]. Only a conceptual framework that takes into account the interaction of the three dimensions of the technical, the social, and the ethical can adequately represent the issues as they concern computer science in practice.

The intellectual space defined by the three dimensions is summarized in Figure 1. The two dimensions shown in detail are the level of social analysis and the particular ethical issues that arise in technology. A third dimension, technology, is indicated, but is not specified strictly in the table. As new technologies emerge, their ethical and social implications can be examined by looking at the various constructs represented in the table. Each of the ethical concerns, represented by a column in the table, have been dealt with at great length in both popular and academic venues [3, 10, 19, 20]. Each of the levels of social analysis represented by the rows of the table also have a literature associated with them that includes numerous references [16, 21, 27]. The combination of these two dimensions results in such an overwhelming wealth of research and analysis that it might be difficult to determine where to start. Fortunately, we have a clear rule to help us determine our starting point. What topics, principles, and skills from this array will be relevant to computer science students at the undergraduate level? A fundamental part of any topic to be covered is consideration of issues arising for computer professionals and are often dealt with in codes of ethics [22].

2.2 A pedagogical framework

Computing Curricula 1991 specified four knowledge units under social, ethical, and professional issues within the common computer science core requirement. However, not much guidance and very little time was allocated (only 11 out of 271 total lecture hours were specified by the curriculum) for the implementation of these requirements. Using the conceptual framework shown in Figure 1, we have redefined the core curriculum for ethics and social impact to be expressed as five necessary knowledge units with learning objectives, rather than specific courses, to allow different institutions and programs to package the subject matter in different ways. The five fundamental knowledge units proposed for this "tenth" subject area, designated Ethical and Social Impact of Computing (ES), are shown below:

ES1: Responsibility of the Computer Professional: Personal and professional responsibility is the foundation for discussions of all topics in this subject area. The five areas to be covered under the responsibility of the computer professional are: 1) history of the development and impact of computer technology, 2) why be ethical? 3) major ethical models, 4) definition of computing as a profession, and 5) codes of ethics and professional responsibility for computer professionals.

ES2: Basic Elements of Ethical Analysis: Three basic elements of ethical analysis that students need to learn and be able to use in their decision-making are: 1) ethical claims can and should be discussed rationally, 2) ethical choices cannot be avoided, and 3) some easy ethical approaches are

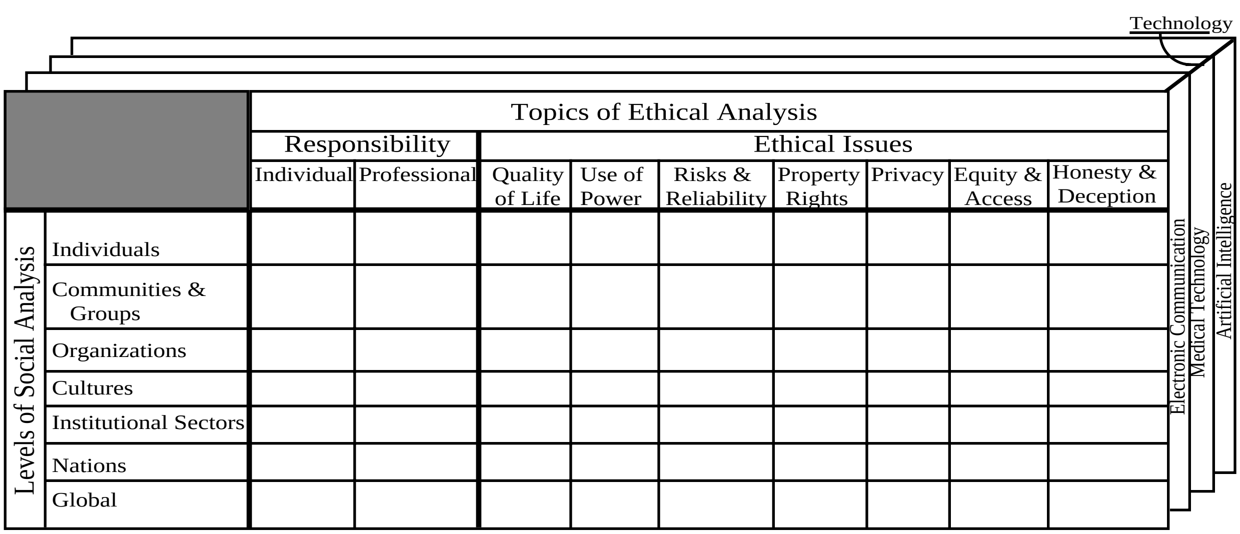

Figure 1. The intersection of ethical and social analysis

questionable.

ES3: Basis Skills of Ethical Analysis: Five basic skills of ethical analysis that will help the computer science student to apply ethics in their technical work are: 1) arguing from example, analogy, and counter-example, 2) identifying stakeholders in concrete situations, 3) identifying ethical issues in concrete situations, 4) applying ethical codes to concrete situations, and 5) identifying and evaluating alternative courses of action.

ES4: Basic Elements of Social Analysis: Five basic elements of social analysis are: 1) the social context influences the development and use of technology, 2) power relations are central in all social interaction, 3) technology embodies the values of the developers, 4) populations are always diverse, and 5) empirical data are crucial to the design and development processes.

ES5: Basic Skills of Social Analysis: Three basic skills of social analysis appropriate for computer professionals are: 1) identifying and interpreting the social context of a particular implementation, 2) identifying assumptions and values embedded in a particular system, and 3) evaluating, by use of empirical data, a particular implementation of a technology.

An effective way to teach these knowledge units is to provide students with the opportunity to identify stakeholders and ethical issues in concrete situations [4, 28]. In this way they come to realize that technology does not simply "impact" society in a one-way causal chain, but society also influences the shape and development of technology. They are also made aware that social relationships have implicit and explicit considerations of power and that those power relationships may shift as a result of the new technology. Another important idea is that the situations in which a technology will be used, the people who will use that technology, and the uses to which it will be put, are all more varied and diverse than one might first expect. To assess these implications, students are expected to systematically collect and analyze empirical data gathered in a social context.

2.3 Developing a curriculum

The amount of time spent dealing with the knowledge units is important — a minimum of 15 lecture hours and 25 laboratory hours of the curriculum should be allocated for this material in order for students to gain an in-depth understanding of the basic elements and skills. In addition, it is strongly recommended that another 10–15 lecture hours be spent on in-depth coverage of topics such as privacy, computers in medicine, computers in education, and computer crime to enable the students to apply the basic elements and skills to real issues (see Table 1).

KU	lecture hours	laboratory hours
ES1	3	6
ES2	3	4
ES3	3	6
ES4	3	4
ES5	3	5
In-depth topics	10	(optional 5 - 10 hours)
total hours	**25**	**25 - 35**

Table 1: Minimal implementation of ES Knowledge Units (KU)

The implications of such a time commitment are important within the constraints of a typical computer science curriculum. The strategy chosen by a particular programme to implement this new subject area should be pedagogically driven. This content should fit into the rest of the program in an integrated fashion so that the relationship between the knowledge units in this area and the rest of the curriculum is apparent to students. The five knowledge units given above can become part of a computer science curriculum in many different ways. At a minimum it means the addition of another 3-credit required course in the curriculum. Fortunately, many good model syllabi and textbooks exist for such a course [2, 8, 9, 10, 13, 16, 19, 20, 21, 27]. A weakness of such a course is that it only requires that one faculty member will be familiar with the material.

Teaching the ethics and social impact strand can also be accomplished by incorporating a set of modules into other computer science core courses [26] if there are enough faculty members committed to including the material as a significant part of their computer science courses. This means that a social and ethical impact module should be incorporated into many of the traditional undergraduate computer science courses such as introductory programming, data bases, programming languages, operating systems, AI, and software engineering. Another approach is to include several of the knowledge units in a "capstone course", a senior-level project course emphasizing skills and knowledge required to become a responsible computer professional [15].

The best way to implement these requirements is to use a combination of strategies: a required course plus integration of material into other courses. If only one strategy is possible, however, the integration of social and ethical issues into existing courses is the preferable option because it helps the student to understand the connections among technical, ethical and social problems.

2.4 Unbelievers still!

In spite of an increasing awareness of the importance of providing an ethical and social context for computing, there are still computer science professors who remain unconvinced that such topics are an appropriate, let alone essential, part of the computer science curriculum. After the second ImpactCS Report was published in *CACM* in December, 1996 [23], a letter to the editor appeared in the April edition in which one former and one current computer science department chair questioned the proposed ES Knowledge Units:

> … the most glaring problem is that proposed subject matter is not computer science...the content of the 'strand' has no algorithms, no data structures, no mathematical analysis, neither software development nor software design, no computer science theory. In short the content is devoid of every standard element present in computer science research and education. … It's hard to imagine a computer scientist teaching these things. … Ethical and social concerns may be important, but as debating the morality of nuclear weapons is not doing

physics, discussing the social and ethical impact of computing is not doing computer science. [6, pp. 20-21]

Like many of their colleagues, they objected to computer science professors teaching ethics and social impart and argued that only philosophers or sociologists should worry about ethical and social concerns. Such a narrow view of computer science would seem to imply that areas such as software engineering and human-computer interaction would largely fall outside computer science. Interestingly, even Turing's ground-breaking paper, "Can Machines Think?", might not be considered computer science by this definition.

3 Case study: Internet content labeling and blocking technologies

To provide you with a compelling example of how tightly bound the ethical and social is to the technical, I would like to now present a case study of a recent development on the Internet, that rapidly evolving new technology for which our profession bears both the pride and the curse of responsibility. Developed initially as a way of fostering research interaction among a relatively small group of users, the Internet has gone public in a big way. It is estimated that there are now tens of millions of on-line Internet users and that over one million of them are below the age of 18. With the explosive growth of on-line services and Internet access, especially through services such as America On-line (AOL), CompuServe, and Prodigy, this surge of new users has also brought an increase in the availability of adult-oriented content and services, much of which is considered inappropriate and even harmful for young people. The areas of greatest concern relate to attributes such as sex, violence, nudity, and language.

The situation is further complicated by other factors, such as: Internet controversies involving censorship, anonymity, and government control; the decentralized nature of the Internet; and ill informed media attention. Those who are sincere about preventing censorship on the one hand and enabling legitimate parental control on the other hand, have found themselves in a difficult position. One solution that has been implemented recently is content labeling and blocking. Several different labeling schemes now available allow Internet content providers to either self label or to be labeled by third parties with respect to any number of attributes.

3.1 Content labeling systems

The basis of any content labeling system is the way in which it content is classified. Federman [11] has used the terms "descriptive" versus "evaluative" to characterize content labeling methodologies. In addition, the terms "deterministic" versus "non-deterministic" as well as "voluntary" versus "mandatory" characterize the labeling process itself [24]:

- *descriptive* – a rating system that provides a description of the content of the labeled media and can provide a set of indicators about different content categories.
- *evaluative* – a rating system that makes a judgment about content using a standard of harmfulness and typically provides a single rating indicator, usually based upon age;
- *deterministic* – a rating process based upon some objective methodology in which the final rating is the result of following the methodology;
- *non-deterministic* – a rating process based upon the opinions of a rating body;
- *voluntary* – the content producer is free to choose to rate or to have the product rated;
- *mandatory* – the content producer is required to rate or to have the product rated by some other agency.

No rating system is purely descriptive or deterministic. Rather, each system varies with respect to where it falls between extremes. Most people are familiar with the Motion Picture Association of America (MPAA) rating system in which a board of reviewers examines the content of a film and then issues an evaluative, non-deterministic rating. The process is non-deterministic because, while general rules of thumb may guide the reviewers' decisions, the process itself is opaque and the results are sometimes at odds with other ratings. It is evaluative because the ratings do not describe the content of the film, but rather which age groups may see the film. Another example would be the content labels on food sold in the United States. They can be categorized as descriptive, non-evaluative, mandated by government, and produced by either the food manufacturer itself or a third party laboratory.

3.2 Content labeling of interactive media

In 1994, a number of Senate hearings were held regarding the increasing levels of violence in computer games. To address these concerns and to deflect possible government regulation of this media, two major content classification systems for interactive electronic entertainment were developed in the United States. These are known as the Recreational Software Advisory Council (RSAC), developed by a coalition of over 25 organizations led by the Software Publishers Association (SPA), and the Entertainment Software Rating Board (ESRB), sponsored by the Interactive Digital Software Association (IDSA). Both were established in 1994.

Both groups are independent, non-profit organizations, but the two content advisory systems are fundamentally different from each other. The RSAC system is a content-based advisory system based upon self-disclosure using an interactive ratings package. The ESRB system is an age-based advisory system based upon the decisions of a rating board. The RSAC system has been used mainly by manufacturers of computer games, while the ESRB system has been used for both video platform games, such as Sega and Nintendo, and computer games. Currently most major toy retailers, such as Walmart, Sears, and Toys 'R Us, require that computer games carry either an RSAC or ESRB label to be sold at their stores.

Also in the United States, a similar public outcry about pornography on the Internet led eventually to the passage of the Communications Decency Act (CDA) at the end of 1995. Realizing that the CDA would probably be found unconstitutional and that voluntary industry action was needed, a number of Internet-specific labeling activities occurred: 1) the Information Highway Parental Empowerment Group (IHPEG), a coalition of three companies (Microsoft Corporation, Netscape Communications, and Progressive Networks), was formed to develop standards for empowering parents to screen inappropriate network content; 2) a number of standards for content labeling were proposed, and 3) a number of services to block inappropriate content were announced, such as CyberPatrol, Internet Filter, NetNanny, and SurfWatch.

By August, 1995, much of the standards activity was consolidated under the auspices of the World Wide Web Consortium (W3C) when W3C, IHPEG, and twenty other organizations agreed to merge their efforts and resources to develop a standard for content selection. The result of the agreement is the Platform for Internet Content Selection (PICS) standard that allows organizations to easily define content rating systems and enables users to selectively block (or seek) information. It is important to stress that the standard is not a rating system like MPAA or RSAC, but an encoding method for carrying the ratings of those systems. Those encoded ratings can then be distributed with documents or through third party label bureaus.

By April 1996, the RSAC computer game rating methodology was adapted for Internet content under the name RSACi using the PICS encoding standard [31]. The RSACi system is a Web-based questionnaire that queries the user about the content of a Web page or directory tree based upon the content categories shown in Figure 2. Upon completion of the questionnaire, a PICS metatag is returned to the user to be placed in the file header of an entire web site, directory or single page or file. There is also the option to place the RSACi symbol on the web page. This service is currently free to anyone interested in labeling the contents of a web site. As a non-profit organization, RSAC has the mission of providing information to the public: "The RSACi system was developed to provide parents and consumers with objective, detailed information about the content of an Internet site, allowing them to make informed decisions regarding site access for themselves and their children" [31].

The RSACi metatags can be used at several different levels to block objectionable content. The individual parent or teacher with a PICS-enabled browser such as MS Internet Explorer 3.0. can activate the blocking mechanism by setting the maximum acceptable levels for the four content areas of nudity, sex, violence, and language and issuing a password to the computer system. There is also the capability to block all unrated sites from downloading into the computer. Thus, the parent or teacher can cause unrated sites and sites with high ratings to be blocked from access until the blocking mechanism is disabled with the password. Similarly, the blocking mechanism could be used at the server or Internet service provider level for intranets or local area networks connected to the Internet at a single point of source.

The implicit assumption with the PICS-compatible labeling and blocking systems described in this paper is that the parents are in control of and responsible for setting the system options on their home computers. Many naysayers have stated that this is actually not the case in many homes; instead, it is the children who are more computer savvy than the parents, and they would be able to circumvent any security features that the parents try to institute. This problem can be best addressed with a vigorous public education campaign to help inform parents how to activate the new features now available in their browsers. It can also be addressed by the browser developers if they make the feature very easy for parents to use. "The truth is, filters can be bypassed by extremely clever kids, but overall they create a more secure environment to deal with the problems of parental content control better and in a freer way than any government could" [7].

3.3 Related policy issues

The issue of content labeling of interactive media touches upon numerous key policy issues currently under debate. I will only mention three in this paper.

3.3.1 Impact on TV rating systems

Running parallel to the development of a self-regulatory system for both computer games and the Internet has been the another highly politically charged debate in the United States: rating content on television. A V-Chip amendment was successfully passed as part of the Telecommunications Bill. The amendment contained a mandate to the TV industry to develop a content rating system for television within a year or have one legislated by Congress. It also mandated that television set manufacturers

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
VIOLENCE: LANGUAGE: content may include				
Harmless conflict: some damage to objects	Creatures injured or killed; damage to objects; fighting	Humans injured or killed with small amount of blood	Humans injured or killed; blood and gore	Wanton and gratuitous violence; torture; rape
NUDITY: LANGUAGE: content may include				
No nudity or revealing attire	Revealing attire	Partial nudity	Non-sexual frontal nudity	Provocative frontal nudity
SEX: LANGUAGE: content may include				
Romance; no sex	Passionate kissing	Clothed sexual touching	Non-explicit sexual activity	Explicit sexual activity; sex crimes
LANGUAGE: content may include				
Inoffensive slang; no profanity	Mild expletives	Expletives non-sexual anatomical references	Strong, vulgar, or hate language; obscene gestures	Crude, explicit sexual references; extreme hate language

Figure 2: RSACi Content Advisory Categories

would be required to include the V-Chip in all new TV sets built starting in 1998. The TV V-Chip would block television material based upon labeling information carried in the TV signal, in much the same way that an Internet browser blocks the access to Internet content based upon labeling information in the file headers.

Throughout 1996 a television industry steering committee headed by Jack Valenti deliberated on what such a TV rating system should look like. Diverse groups, such as RSAC, the National PTA organization, Children Now, medical organizations, and academic institutions involved in research on the effects of violence on children, participated in the discussions. Recommendations from those groups suggested that a TV rating system should be content descriptive, not age-based, and overseen by an independent body with representatives outside of the TV industry to include child experts, psychologists, and children advocates. In fact several groups endorsed an RSAC-like system for television.

However, the new proposed TV ratings system, unveiled in January, 1997, will be completely controlled by the industry with no outside involvement. In spite of a unanimous call from virtually all interested parties for a content-based, descriptive rating system to be tied in with the V-chip, the industry group chose an age-based system that mirrors the one used by the movie industry. As a result of what has been construed as a lack of good faith on the part of the television industry to be socially responsible, the United States Congress is once again threatening to legislate a rating system for television.

3.3.2 Global implications

The threat of governmental censorship of electronic media provided the main impetus for the formation of RSAC and the development of PICS. Until this point, we have only considered this issue with respect to the United States. However, an oft cited characteristic of the digital realm is its global scope. This can increase the difficulty of developing a content labeling system because the cultural norms of violence, language, sexuality, and political freedoms differ across the globe, and there are no cultural boundaries in cyberspace. Hence, content that may be considered appropriate within one culture may be considered inappropriate to others. Countries such as Australia, Great Britain, Singapore, the Netherlands, and France have all expressed interest in the RSACi system as an international labeling standard. Some countries may associate the various icons or names with the ratings differently, but the numeric value of a descriptive rating would stay the same.

3.3.3 Regulation of the Internet

Based upon the activity that has occurred in the three different US industries —computer games, the Internet, and television— it appears that it is rare for a group of companies within an industry, who are usually fierce competitors with each other, to voluntarily set up a rigorous self-policing system that will cost its members time and money to administer, promote, and develop. This would run counter to the mission of most trade associations *unless* there was a very real and potent threat of similar, if not worse, legislation coming from government. On the other hand, it is the role of government to reflect the legitimate concerns of the public and to bring these issues to a wider audience through hearings, press conferences, and possibly draft legislation. Thus, it is often that government uses its power to embarrass, criticize, or even humiliate an industry into recognizing its shortcomings, in short to browbeat them into compliance with socially responsible goals. With the right oversight and controls, self-regulation is far more attractive than government regulation, but it takes time, money, and resources to make it work.

4 Conclusions

What I have tried to demonstrate through this case study of content rating and blocking on the Internet is the interrelationship between the three dimensions stated previously: the technical, social, and ethical implications of a new computer technology. From the technical perspective, there are the issues of standards such as PICS, the evolving communications protocols, computer security, and all of the new client-server hardware and software technologies. From the perspective of social analysis, we can see that this is an issue effecting individuals, communities, organizations such as trade associations and advocacy groups, institutional sectors such as education, government, and business, and even national versus global interests. From the ethical perspective we can see that issues of individual and professional responsibility are involved, as are personal and community values, quality of life, the use of power, privacy, equity of access, and even the honesty of the ratings. Thus this case study illustrates how essential it is for our computer science students to be equipped with both the skills and the experience in wrestling with complex scenarios such as this. They may not only be called upon to design the systems and software of the future, but they may also be called upon to testify before governmental hearings or to participate in the governance of the virtual worlds they will create.

The real issue for computer science educators, of course, is not defining computer science precisely, but teaching our students about the profession of computing. To suggest that students do not need to be taught about computing professionalism would also suggest that we do not need to teach them anything about writing specifications or documentation, how to make a technical presentation for a walkthrough, how to do code reviews, or even how to debug their programs, because none of these things are purely computer science either.

> Societal and technical aspects of computing are interdependent. … Far from detracting from the students' learning of technical information, including societal aspects in the computer science curriculum can enhance students' learning, increase their motivation, and deepen their understanding [26, p. 37].

The ImpactCS Project has provided a coherent and integrated approach to teaching a well-defined set of social and ethical analysis skills to computer science students, which will sharpen their general thinking and problem-solving skills and give them a more holistic view of their profession and their own professional responsibility. It is our hope that this new definition of the subject area will also become part of the standards in the accreditation process for computer science programs in the future.

In the final analysis, why is all of this really important to computer science education as well as to the computing profession as a whole? There is a common public perception that many computer experts are unethical "hired guns." Many of you may have seen the cartoon of the computer hacker bemoaning the fact that all the major networks have already been broken into and stating that computer science is the only profession where committing a felony is considered a career move. Our ultimate challenge as computer science educators then is to help mold a lot of bright hackers into ethical professionals or, as a teacher's wall plaque states, "take a lot of live wires and see that they are well-grounded!"

6 About the author

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