Abstract

This paper discusses social issues of Computer Science in the context of the preparation of high school Computer Science teachers. Specifically, it focuses on the importance of addressing social issues in the Methods of Teaching Computer Science in the High School course and illustrates the actual teaching, in the course, of the following three social issues of Computer Science: ethics, diversity, and history of Computer Science.

1. Introduction

This paper continues our series of papers about the Methods of Teaching Computer Science in the High School course (henceforth abbreviated to MTCS), focusing on how to address in the course social issues of Computer Science (CS), such as diversity and ethics, which deal with the community of CS professionals.

The need to tackle such topics in the framework of CS teacher preparation programs emerges from the growing recognition that such topics are indeed part of the discipline of CS. This fact is well reflected, for example, in the Computer Science volume of the Computing Curricula 2001. According to this volume, one body of knowledge of Computer Science is SP – Social and Professional Issues, which is composed of 16 core hours, within which the following topics are core topics:

SP1. History of computing (1 hour)
SP2. Social context of computing (3 hour)
SP3. Methods and tools of analysis (2 hour)
SP4. Professional and ethical responsibilities (3 hour)
SP5. Risks and liabilities of computer-based systems (2 hour)
SP6. Intellectual property (3 hour)
SP7. Privacy and civil liberties (2 hour)

We would add that the attention given to social issues is highlighted also in the context of other scientific domains. For example, this perspective is encapsulated in the Science, Technology, and Society (STS) movement that studies the relationships between these three elements and combines a cross-disciplinary approach combining engineering, humanities, natural sciences and social sciences.
In what follows, we illustrate the actual teaching of social issues of CS in the MTCS course.

2. Active learning-based teaching of social issues in the MTCS course

In our second paper about the MTCS course (Hazzan and Lapidot, 2004) we proposed an active learning-based teaching model employed in our MTCS course. Our model consists of four stages (Trigger, Activity, Discussion and Summary), which all focus on the topic we wish to address in the course. In this paper we illustrate, using three (out of many other possible) CS social issues, how we implement the same model to teach social issues of CS as well. Specifically, we focus on ethics, diversity and the history of CS. The triggers and activities presented here are only illustrative examples and, clearly, other alternative options exist.

2.1. Ethics in Computer Science and in Computer science Education

Ethics is part of the discipline of philosophy. The New Shorter Oxford English Dictionary defines ethics as “the science (or set) of moral principles; the branch of knowledge that deals with the principles of human duty or the logic of moral discourse.” The Webster’s Collegiate Dictionary adds that ethics is “the discipline dealing with what is good and bad and with moral duty and obligation.”

Some communities of practice have a well-defined code of ethics (e.g., The Code of Medical Ethics). The role of such codes of ethics is to guide professionals on how to behave in vague situations where it is not clear what is right and what is wrong. The need for a code of ethics arises from the fact that any profession generates situations that can neither be predicted nor answered uniformly by all members of the relevant professional community. In practice, ethics is most often needed when a conflict arises, between two (or more) possible legal actions. Since all of the alternatives are legal, ethics may help solve conflict of interests, at least in part.

A relevant question to be asked at this stage is: Does the community of CS educators need a code of ethics? If yes, what situations should be addressed by such a code of ethics? What should its principles be? Clearly, it is not our intention in this paper to formulate a code of ethics for the community of CS educators. However, since there are cases in which the ethical dilemmas faced by CS teachers are similar to those faced by computer scientists, and there are also situations that are unique to CS teachers, we propose that the ethics of CS educators be derived both from educational ethical norms as well as from the ethical norms of the community of computer scientists. In other words, in practice, CS educators should base their ethical norms on one of the many available existing educational codes of ethics\(^1\) and on the accepted Software Engineering Code of Ethics and Professional Practice\(^2\), formulated by a IEEE-CS/ACM Joint Task Force, which outlines how software developers should adhere ethical behavior\(^3\).

\(^1\) See for example, the New York State Code of Ethics for Educators: http://www.highered.nysed.gov/tcert/restoreachers/codeofethics.htm#statement
\(^3\) We are aware that not all computer scientists are software developers. However, we do assume that the majority of the CS community might face ethical dilemmas that emerge from software development situations.
This perspective highlights the ethical complexity that CS teachers must deal with as well as the importance of dealing with the concept of ethics within the framework of CS teacher preparation.

The following activity aims at increasing the prospective CS teachers' attention to situations that their profession might bring them face with and at delivering the message that their behavior should be based on moral norms.

In the course, the activity starts with the following trigger, on which the prospective teachers work on in groups.

**Trigger:** Each group works on a hypothetical situation, taken from the life of a CS teacher (or from related situations), that raises an ethical dilemma. Each group must discuss:
- Whether or not there is an ethical dilemma in the described situation, and, if so, they are asked to identify and describe it;
- How can the ethical dilemma can be solved; and
- What ethical rule (or rules) should be formulated to guide CS teachers in similar situations.

Table 1 presents two situations that raise ethical dilemmas. The first relates to a school situation directly; the second—indirectly.

**Table 1. Triggers about Ethics in CS Education**

<table>
<thead>
<tr>
<th>Case 1</th>
<th>Case 2 (based on Tomayko and Hazzan, 2004):</th>
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<td>One of your pupils downloaded a software tool from the web that helps your students in their understanding of one of the complicated topics studied in the high school CS curriculum. The rules state that the software should be paid for after 30 days of trial usage. As it turns out, your school does not have the required budget to pay for it. It is, however, possible to reinstall the software in 30-day cycles and avoid payment.</td>
<td>Your friend works for a software house that specializes in the development of computer games. Recently, several publications have indicated that these games influence some children negatively. These games, however, are the main product of your friend's company and without them the company may not be able to survive. The company’s management is aware of these publications and gathers all the employees to discuss the future of the company. You are invited to the meeting as a representative of the educational system. Answer the following questions:</td>
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<tr>
<td>- How would you behave in such a situation?</td>
<td>- Suggest different opinions that might be expressed in the meeting. What (if at all) ethical consideration does each of them represent?</td>
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<tr>
<td>- Formulate (one or more) ethical principles that will help you make a decision in similar cases.</td>
<td>- What (if at all) conflicts of interest are presented in this case?</td>
</tr>
<tr>
<td>- What is your opinion with respect to this case?</td>
<td>- What is your opinion with respect to this case?</td>
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</tbody>
</table>
- How would you behave in such a case?
- Formulate (one or more) ethical principles that might help make a decision in similar cases.

After the students work on the task for about 20 minutes, the different groups present their cases and express their opinions with respect to the different questions. Specifically, after the source of ethical dilemma is observed in each case, focus is placed on specific solutions that might solve it. This discussion delivers the message that ethical considerations should be part of the CS teaching profession and that different solutions can be found that eliminate the ethical dilemmas (at least partially).

2.2. Diversity in CS Education

Diversity is expressed in different ways in any community in general, and in any CS class that may be taught by the prospective teachers in their future professional life in particular. Diversity can be exhibited, for instance, in terms of students' different fields of interest, ways of thinking and perspectives, background, gender, nationality and more. Accordingly, prospective CS teachers should be familiar with the concept of diversity in general and, in particular, with its importance in the context of CS education and with how to take advantage of diversity to benefit their teaching.

In what follows, we present three triggers that address diversity. The first deals with diversity in general, the second – with different approaches towards students' performance, and the third trigger addresses gender diversity – a well-recognized topic in CS education (cf. the June 2002 Special Issue of *Inroads – The SIGCSE Bulletin*).

We note in passing that, in fact, the underlying idea of presenting triggers in itself represents diversity, since triggers should be designed so as to encourage different perspectives and ways of thinking. Furthermore, the pedagogical viewpoint of constructivist teachers, which legitimizes and respects the differences between students, is based on diversity.

**Trigger 1 – in groups:** Describe a class demography that is as diverse as possible.

This trigger is presented to the prospective CS teachers before introducing the concept of diversity. After the students work on the trigger, each group presents its suggested hypothetical class in the MTCS course milieu. The collection of class structures presented at this stage by the prospective teachers a) indicates the prospective CS teachers' level of awareness with respect to diversity, b) increases their level of awareness about diversity, and c) leads to discussions on how to deal with diversity.

**Trigger 2 – in pairs:** The prospective teachers are asked to evaluate three pupil answers to a question given on a real test, administrated at a real high school.

After working on the trigger, each group suggests their philosophy with respect to their evaluation of the answers. The different perspectives exhibited at this stage highlight very clearly that a) there are different perspectives regarding student errors; b) when viewed from the teachers' perspective, this is another way in which diversity is expressed and c) different considerations exist in such situations. More on the theme of evaluation in the MTCS course was presented in a previous paper (Lapidot and Hazzan, 2003).
**Trigger 3:** Table 2 is presented to the prospective CS teachers and they are asked to suggest factors that encourage each gender (or both genders) to study CS (e.g., high status) or discourage each gender (or both) from studying CS (e.g., the image of the field). While the students suggest their ideas, the table is filled accordingly. When student suggestions are presented, we recommend to refrain from passing judgment on their opinions and to simply write fill what is said in the table. Our experience tells us that in most cases, the following picture is clearly observed at the end of this process: Cell [1], which includes factors that discourage girls from studying CS, and Cell [2], which includes factors that encourage boys to study CS, are full, while the other cells remain almost empty.

The class discussion that follows leads students to rethink their perspective regarding gender diversity in CS classes. Particularly, the prospective teachers begin to see their bias very clearly. This increased awareness is used in order to further discuss with the students how to encourage diversity in their future classes.

**Table 2. Factors that encourage/discourage males/females in the choice of CS**

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th>Boys</th>
<th>Both genders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourage</td>
<td></td>
<td>[2]</td>
<td></td>
</tr>
<tr>
<td>Discourage</td>
<td>[1]</td>
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Following this discussion, data about gender diversity (such as, statistics from different countries) are presented to the students and the importance of diversity is discussed.

**2.3. History of Computer Science**

By dealing with the history of CS in the MTCS course, two main objectives may be achieved. First, we suggest that such a discussion contributes to the professional perception of the prospective CS teachers (Hazzan and Lapidot, 2004) in general, and in particular, may explain the structure of the curriculum. Second, dealing with the history of the profession of CS may increase the prospective CS teachers' awareness to the fact that CS goes beyond programming.

In what follows, we present a lesson, taught in the MTCS course, that is dedicated to the history of CS. The lesson starts by asking the prospective CS teachers what they know about the history of CS. The students usually answer in a single sentence: "It is short; about 50 years". We continue with the question: "Why is it important that CS teachers know the history of CS?" Here are several typical answers that are usually suggested at this stage: "To illustrate their knowledge to their pupils"; "To use different ways for introducing topics"; "To have a wide perspective about what they teach", "To understand the curriculum" and "To become familiar with people who influenced the development of the field."

At this stage, when the students are conceived that as CS teachers they should know more about the history of CS, they are presented with the following task:

- Construct a lesson about any CS topic that includes a 10-minute presentation about the history of CS. You are given a set of links that address the history of CS. You can, or course, use other resources.
For illustration, we present three examples of topics chose by the students:

a. The source of words such as bug, algorithm, Ada.

b. The history of object-oriented software development: Specifically, different programming languages that marked the development of this paradigm (e.g., Simula, C++, Java) were mentioned. Furthermore, the students' realization that the concept of object-oriented development was first introduced in 1962, highlighted the fact that it sometimes takes time for new ideas to be accepted by a community of professionals.

c. The history of computers: The fact that the first computing machines were developed about 200 years ago (and even earlier) led to a sequence of discussions. One of them addressed the question: "When did such machines start being computers?" That discussion was followed by a discussion about the definition of the term computer.

After the students present their 10-minute presentations about the history of CS and the discussions that follow each presentation are completed, we re-examine the question that opened the lesson - "What do you know about the history of CS?" Naturally, by this time, the one-liner answer given at the beginning of the lesson ("It is short; about 50 years") is greatly enriched. The lesson ends with a discussion of whether the history of CS really is that short.

The entire lesson can be viewed as a trigger that aims at elevating the prospective teachers' awareness to the very existence of the history of CS and to its main milestones. This lesson can be continued in different ways, including a full course that focuses on the history of CS, a task that delves deeper into some of the topics discussed in the lesson, a project in which each student researches one persona from the history of CS, or another lesson that explores how to integrate the history of CS into the high school CS curriculum.

3. Conclusions

There are many other social issues related to CS, such as teamwork, program comprehension, understanding software requirements, business issues and more (cf. Tomayko and Hazzan, 2004). We suggest that, in the same spirit presented in this paper, these topics can also be addressed in the MTCS course or in other relevant CS courses.

References

