

# Teaching and Learning Ethics in Computer Science: Walking the Walk

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## ABSTRACT

The author shares techniques used in a successful "Ethics and Professionalism" class at California State University, San Bernardino. The author describes active learning and holistic grading techniques in particular. Ethical issues lead to a novel way to post grades on the web without exposing personal data. This was evaluated by students. The author points out some improvements he has made, or will make.

## Categories and Subject Descriptors

K.3.2 Computer and Information Science Education, K.4.1 Ethics, K.6.5 Security and Protection

## General Terms

LEGAL ASPECTS

## Keywords

pedagogy, ethics, information security, privacy, grading, active learning

## 1. INTRODUCTION

*Suppose you are a faculty member in a college in California and keep your grades and rosters in an unencrypted spread sheet on a workstation running a Windows operating system. Describe two(2) distinct scenarios that expose personal student information(1 paragraph each). What should you do about each?(1 paragraph each)*

The above is the kind of scenario I use in teaching ethics (with small changes to make it appeal to an audience of teachers). This paper includes some ideas that would appear in a good answer to this question. A recent ethics course[1] was the most successful course I have ever taught. The student evaluations were so much better than my norm that it is worth noting what I did. The course used active learning[2] and holistic scoring[7]. A new technique for posting grades made identity theft impossible.

In the Fall of 2003, I taught our "Ethics and Professionalism" class for the second time in 6 years. By nearly every criterion the course was a good one. (1) I have clear evidence that all the students achieved my objectives. (2) The student evaluations were the best I have ever had. (3) Anonymous surveys showed that nearly all students liked the innovative way of posting grades. (4) The same surveys in another class indirectly showed that the Ethics course had improved the students understanding of privacy. (5) The course taught me that ethical considerations are vital input into software design. (6) The course was too successful: most students got an A or an A-.

This paper reviews what I did, how the students responded, and what improvements I plan to make. In section 2 I describe the course and my approach to teaching it using active learning. In section 3 I focus on essay questions and how to grade the answers. Section 4 describes the development of a small piece of software to allow students to see their grades without exposing them to identity theft. Section 5 summarizes my conclusions and section 6 acknowledges support of the US National Science Foundation. Section 7 contains the references cited in the paper.

## 2. BACKGROUND

### 2.1 The Course

The class is a 2 quarter unit course entitled "Ethics and Professionalism." The catalog description is *Professionalism, ethics, legal issues and social impact and role of computer technology*. It is required for all Computer Science majors in their senior year. It is scheduled each Fall with ten 2-hour classes plus a 2-hour final. Different teachers teach it. The class size is 40 students. We have a diverse student population with a range of cultures, ages, and genders. I had students from every continent in the world. The text was Spinello's *CyberEthics: Morality and Law in Cyberspace* [6].

This is topical and good on ethical theory and legal issues. I encourage students to read articles and papers in newspapers, magazine, professional journals and on the Internet. The course web site has copies of the syllabus, a web log, and course related links and resources[1]. I use my own software to generate these web sites from an ASCII-based notation.

### 2.2 Objectives

In the syllabus the goals are stated as: *To help improve your long term survival in computing by increasing your knowledge, awareness, and thinking about nonmechanical problems facing a computing professional. To help you to act better when faced with*

*difficult choices*. I refined this to requiring evidence of students thinking through ethical problems using material from the book. This was assessed by asking students to write 30 minute structured closed-book essays on realistic topics or problems. The first nine classes ended with the presentation of a scenario, subject, or question and the request for the students to write an essay on the topic. This was handed in, graded and returned at the start of the next class. All but the first and last essay counted and contributed 40% toward the total grade for the class. Similar essays made up the final examination and contributed 40% of the final grade.

It is essential that grades are assigned to the person who did the work[5]. So, in this class, assigned work was nominal and contributed only 14.4% to the grade. The rest is supervised work. I do not use electronically submitted work because most current technology (1) is slower to use than paper and (2) fails to provide adequate assurance that the work is done by the student.

### 2.3 The Classroom

The classroom is a typical 40-seat room. It had a projector, speakers, a VCR, a PC with Internet connection, a CD/DVD player, etc. I use the equipment to display course materials and topical web sites -- ACM, IEEE, Lexis, Wired, and Google.

### 2.4 Design for a Class

All students are required to read and study a piece of the text to prepare for each class. As evidence they hand in their rough notes at the start of class. I set them a preliminary discussion question on the topic in the reading, ideally taken from current events. Students are told to think individually and silently about the question and write down their thoughts. They are then told to form a pair and compare their thoughts. Each pair then joins with another pair to generate a common answer that is then shared with the whole class. This is the well known "Think-Pair-Square-Share" pedagogical pattern [2]. While the students did this, I graded the notes (100% if OK, else 0%) and collated them with previously graded work using a sorter. I return the work by calling out people's names, as the students continue to work in "squares." This lets me take the roster without wasting time. Each "square" then reports to the class.

The class then goes on to a series of shorter "Think-pair-square-share" exercises. One variation is to ask the students to think about the assigned reading and select a question they want answered. Each group of four asks a question. I and other groups provide answers. Again, whenever possible I call on people by name (initially I use the roster). This is a motivator and places names in my long term memory.

At the end of the class, I set a 30-minute (closed book) written essay. This is graded and returned at the start of the next class.

### 2.5 Make up work

I allowed one form of make-up work: a student can make a presentation to the class of a relevant topic or situation. This led to some good sessions when worried students brought up problems and the class provided advice and comfort.

### 2.6 Evaluation of the Class Process

There is little chalk-and-talk and no bulleted visuals. This depends on having resources that do not need explaining or extending in

class. The students are *working* the whole time. The work involves individual thinking and comparing different views. The teacher has the responsibility to control the flow ("*How do we apply Kant's Categorical imperative here?* <pause> *What do you think, Jo?*"). The teacher also lists answers on the board, compares, contrasts, and summarizes them, digs out missing ideas, and corrects errors ("*Do that and you could go to jail!*").

## 3. ESSAYS

### 3.1 Example Questions

Here are three questions

1. *You see your teacher view some child pornography and save it to a Zip Disk.* **a.** *Show how **two different** theories of ethics apply(4 paragraphs).* **b.** *How does applying ethical theories help you plan your actions?(1 paragraph)*

2. *Spam!* **a.** *Give an example of how (1) code, (2) the market, (3) norms, and (4) law could control it(4 paragraphs).* **b.** *What do you judge will be most effective? Why? (1 paragraph)*

3. **a.** *Name and describe four(4) types of intellectual property(4 paragraphs).* **b.** *Why do laws protect intellectual property? -- give several reasons(1 paragraph)*

### 3.2 Grading Essays

It is important to have a predefined and published procedure for grading. This should not vary after the last day that a student can drop. For essays, I make it clear that I am more interested in well reasoned argument than agreement with my opinions. The first essay in the course models the grading but the score is not recorded. I have modified the idea of Holistic Scoring developed by English Language faculty [7]. The procedure is to read the item rapidly and assign a score to it based on my published criteria. I attach a letter grade to each paragraph as I finish it. I also mark any mistakes or omissions as I read. The letters map to scores: A=10, B=9, C=8, D=7, E=6, and F=0. These are averaged, scaled, and rounded to give the score for the essay (0..25 in classes, 0..50 in the final). These in turn are totaled across the course.

The syllabus defines what each letter grade means. For example an *A* paragraph was described as: *Easy to read, structured, no gross spelling mistakes or grammatical goofs. Content is accurate when factual, well reasoned when debatable, or well expressed when personal and subjective. Sources are given for all non-original work. The original work seems to be something special that you wanted to say. Good use of mathematical ideas and formula. Any humor is an intelligent and polite way to make a relevant point.*

A *D* paragraph was described as *Work that makes your boss wonder about your next pay rise. Many errors of structure, spelling, grammar, fact, and logic. No references. Many ambiguities. Hard to figure out. Content that is inappropriate. It suggests that you don't know what you want. Mathematics is badly wrong or isn't fitted to the situation. Bad jokes.*

*B* and *C* lie between *A* and *D*. *E* is being worse than a *D*. The *F* is reserved for: *This is identical to something else and you did not say so. F is also used when you omit a required section or topic. Padded, plagiarized, or missing paragraphs.*

A small but an important ethical point: the work must be graded before you know who did it. Expectation easily overrides observation via the halo effect, favoritism, and prejudice. So, I ask students to put their name (and number) *at the end of the work*. I tell them why.

### 3.5 Student Evaluations of Teaching Effectiveness

I asked for a SETE (Student Evaluation of Teaching Effectiveness) in the class. This is the standard instrument used at CSUSB and uses a 4-point scale (Excellent=4, Good=3, Fair=2, Poor=1) on 10 different items such as the instructor's knowledge, preparation, organization, . . . etc. It is carried out in the ninth week of the quarter. I usually score close to the averages for a teacher in the College of Natural Sciences (CNS). This time my median and mode in every question were 4. The averages of all but one rating are close to one standard deviation higher than the CNS average. The best score vs. the CNS average was for explaining the objectives and requirements of the course. This score was more than one standard deviation higher. The weakest (0.5 SD > CNS) was for providing clear feedback in grading.

### 3.4 A Critique of Essay Grading

Students understood the process, but, holistic grades are not good diagnostic tools[6, p 92]. I plan to invent ways of providing better feedback in the future. The scores were very good. Just about every student wrote essays that met my stated criterion for an A. So, in the future, I will raise the bar. What was an A paragraph (see above) will be given a B. An A will be described as something like this: *The paragraph is a pleasure to read. It is clear, structured, accurate, well reasoned, and has no spelling or grammatical errors. Sources are given for all non-original ideas. New ideas are relevant and either humorous or well reasoned.*

Grading 40 essays takes two or three hours. Nevertheless, it was not boring because students introduced their own ideas and expressions.

## 4. POSTING GRADES

### 4.1 Why Post grades?

Letting students know how they are doing motivates them. It also motivates the teacher to keep up. It lets students spot and correct grading errors before the course is over. So, students should be able see their grades on the Web. It helps if they can also get an idea of the class's overall performance.

### 4.2 Information Security and Privacy

A fundamental ethical responsibility is to make sure that a student's personal data does not become known to other people. A teacher at CSUSB is required not to expose students' identities and grades. In the USA, Social Security Numbers have been protected at the Federal level for decades. These days, identity theft is common. In California, if personal data is exposed by a security breach, the people at risk must be informed within 48 hours to avoid a fine (The Security Breach Information Act (SB1386) July 2003). This is discussed in the course. So, the students should be more aware of the need to design computerized systems that protect personal data. So, the teacher of this class, must show due diligence in protecting the student's identity and grades.

All networked computers are under attack these days. At the end of the summer quarter in 2003 several MS Windows computers at CSUSB were invaded by viruses and Trojan Horses. The Computer Science faculty web server (Linux) was hacked into via a badly programmed Common Gateway Interface (CGI). Events like these are clearly security breaches and all the data on a cracked computer is open to abuse. The SQL Slammer virus infected 75,000 servers in its first 31 minutes in January 2004 [4]. Security patches, personal fire-walls, and virus checkers all lag behind the attackers. In Spring 2004, a campus machine was left un-updated for only two days and became a zombie file server for movies. No popular system has been proved secure.

My campus was using Social Security Numbers (SSNs) as student identity numbers (SIDs) at the start of this class. Clearly putting unencrypted SIDs on any machine was no longer ethical. I decided that any SIDs on my computers must be encrypted using a special password as key. I use a spreadsheet with this functionality. Extracting impersonal data from it is easy and uploading it to the server in tab-delimited format trivial. The requirements were: (1) Students can see their own grades. (2) Nobody can figure out other people's grades. (3) Unencrypted names and SSNs must not be placed on any computer connected to the Internet.

### 4.3 Analysis

I looked at creating a traditional id+password system for the class. Such a system must include the ability for users to change passwords and ways to supply alternatives if the password is forgotten. Passwords must not be stored without encryption in case the system is broken into. All this would take time. It would also require students to memorize another id+password. Meanwhile, my systems administrator reacted to the CGI attack by disabling all CGIs. No alternative was set up. As a result I could not use passwords and encryption on the server. I was forced to look for an alternative. I thought a short term secret Id would be simple and secure enough

Asking students to supply a key or identifier can lead to collisions and might lead the unwary to expose personal information. I decided to give each student a temporary secret identity or key. There are several candidates: the SID was eliminated by privacy needs. Names could not be used, and I have had students with identical names. Hashing names and SIDs can generate collisions and needs careful design so that it cannot be reversed. The sequence number in the roster is unique but does not preserve confidentiality. Allocating a random four digit number ( $10^4$  combinations) as identifier would preserve privacy but be difficult to memorize. Three letters give  $26^3 = 17,576 > 10^4$  combinations. Memorizing words is easier than numbers. Visualizing a ridiculous image linking a named object and the teacher will do the trick. I developed a list of 100 suitable words (hen, pea, boy, zoo, hay, . . .).

### 4.4 First Prototype

I used a mail-merge function in a word processor to print out one hundred special forms. Each had a different key. The top of the form was designed to be torn off and kept by the student. It showed their key plus instructions for using it. The bottom half the form was a contract that included the key. Students filled in their name and their SID. It stated the rules for the class such as "no cheating" and "bad work gives a bad grade." This was signed and returned to me.

I then recorded the key in my encrypted spread sheet. Each week, I extracted the grades and the keys, sorted by the key, and posted the tab-delimited ".TXT" tables to the web.

#### 4.5 A Survey of Student Opinions

A wise or ethical software developer checks with his or her clients and users to see what they think about it. In the tenth week, students did an anonymous and optional survey to see if they used, understood, and liked the scheme.

I got 34 responses. Here are the questions and frequencies of the answers in the survey.

1. I checked my CSCI488 grades  
Every day(0), Every week(14), Some weeks(11), Once or twice(6), Never(3)
2. In other classes I check my grades  
Less often(16) -About the same(16) - More often(2)
3. I found the use of a random word as an identifier in posted grades easy to understand.
4. I found the use of a random word as an identifier insecure.
5. I found it hard to use the random word as an identifier.
6. I prefer this method to using part of my Student IDentifying number.
7. I would like to see this scheme used in my other classes.

**Table 1. Responses to question 3 to 7**

#	Strongly agree	Agree	Disagree	Strongly disagree
3	19	13	2	0
4	4	8	15	8
5	1	3	15	15
6	12	19	2	1
7	12	18	4	0

The first question showed that most students checked their grades at least once a week. The second question showed that 16 checked their grades more often in CS488 than in other classes and 16 checked their grades the same amount in other classes. Questions 3 through 7 used a four-point ordinal scale (Strongly agree, agree, disagree, strongly disagree). Two students found the random key hard to understand (question 3), four found it hard to use, and three would prefer that I had used their SID. Thirty (out of 34) would like to see the same scheme in their other classes. Twelve thought it insecure. Answers were correlated. For example, the two students who felt that the scheme was hard to understand, also felt that using it was hard, and did not want it used in other classes.

The last question was open ended and asked for comments. Six students noted that when all the grades are visible you can figure out who was who in the class. Another noted it would be better to only display your own grades. One person thought it was too much hassle, and another suggested making the link to the grading more visible on the CSCI488 page. The remaining ten comments were positive.

#### 4.6 Second Prototype

By then, the department web server had PHP [3] running and I was replacing my CGIs with PHP scripts. I developed a script to extract and format the grading data and linked it to the web site. It asks for the student's secret key and does a simple search in the tab delimited data. It selects lines that match the key plus those with a capital letter in the first column. The selected lines are marked up (by the script) as rows in a HTML table (one table per file). The code is less than 30 lines long[1].

#### 4.7 Posting Grades in Other Classes

I have used the second method for posting grades in later classes. In one (CSci320 Programming Languages, Winter 2004) I used the same survey. The 28 responses were similar. There was one significant difference (using a 2x2 contingency table with Yates's correction,  $\chi^2 = 5.1$ , 1 degree of freedom, P <5%): Students in the programming language class disagreed with the statement "I prefer this method to using part of my Student ID" more often than the "Ethics" students. This shows that the "Ethics" students are more aware of the risks of exposing personal information. This is more evidence of a successful course in Ethics and Professionalism.

#### 4.8 Evaluation of Posting Grades

Most students liked my technique for posting their grades. It cannot expose a person to identity theft. Still, the use of a secret temporary key to access grades can be cracked by waiting until the quarter is complete and then repeatedly hacking codes and looking for patterns.

Kant's Categorical imperative [6] states that one should adopt maxims that are not invalidated if everybody followed them. If a special identity was used in every class, a student would be overwhelmed by keeping track of them. So, using existing accounts is better.

### 5. CONCLUSIONS

#### 5.1 Future Changes

In the future, I want to explore the use of *public key encryption* for grades in the "Ethics" course because *privacy* is a topic in the course. In other courses I could use one of two existing id+password systems. Computer Science students have a Unix account. All CSUSB students have a campus email account and authentication is provided by a special "LDAP" server. Alternatively, the campus is replacing its mainframe information system and student identifiers are being uncoupled from social security numbers. Using part of the SID as a key will then be less risky. The PHP code[1] can easily be modified to handle this.

#### 5.2 Conclusions

It is impossible to say what made this class "excellent" for so many students. There are many intangibles, such as teacher enthusiasm, that drive student response. I use active learning techniques in other classes and get close to average scores. I hope that the students reacted to the effort I put into grading essays and protecting their identities. It will be interesting to see what happens when the grading is tougher.

#### 5.3 Advice

Now is the time to glance back to the question at the start of this paper and see if you would change your answer.

I now encrypt all grade sheets and rosters on computers. Second, I use fake IDs on servers. Third, I use a script so that any student only sees part of the data. Fourth, my scripts must be as simple as possible to avoid being cracked. Finally, I will continue to be visibly ethical when I teach ethics.

## 6. ACKNOWLEDGMENTS

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