Preparing to Teach Computer Ethics:

Results from the DOLCE Project

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Abstract

The *Developing On/Off-line Computer Ethics* (DOLCE) is an NSF sponsored project which held three summer workshops for university faculty members. DOLCE has created web-based materials for teaching computer ethics to undergraduate computer science majors. The materials are closely integrated with the third edition of *Computer Ethics*, by Deborah Johnson[3], and are designed to be used in undergraduate computer science classes or modules. The materials emphasize computer ethics theory and analytical skills, societal issues in computing and telecommunication, and professional ethics. Gender issues in computer ethics are a specific focus. The participating faculty members completed pre and post assessments before and after the summer workshops. Many of the participating faculty members' students were also evaluated using pre and post assessments before and after completing their computer ethics courses or modules. This paper presents the design of the DOLCE workshops and the results of our assessment efforts.

I. Introduction

Responsible computer use is an increasingly important issue. Significant economic harm has resulted from the development and release of unreliable software and from malicious attacks. Computer science students live and will work in an environment in which their professional decisions will affect and be affected by ethical dilemmas. These concerns bring computer ethics to the forefront of discussions in computer education[5,6,7,8].

The Accreditation Board for Engineering and Technology[1] has argued that ethics should be a central theme throughout the computer science curriculum. The content contained in computer ethics is very different from the technical courses computer science faculty completed as graduate students. In other words, computer science faculty are unlikely to have prior training or previous teaching experience in computer ethics. The National Science Foundation (NSF) has recognized this problem and is supporting projects that seek to develop computer science teachers' knowledge and understanding of computer ethics and how to teach computer ethics.

This paper focuses on one such NSF funded project (NSF CCLI-DUE: 9952841), *Developing On/Off-line Computer Ethics* (DOLCE). DOLCE has created web-based materials for teaching computer ethics to undergraduate computer science majors. The materials are closely integrated with the third edition of *Computer Ethics*, by Deborah Johnson[3], and are designed for use in undergraduate computer science classes or modules. The materials emphasize computer ethics theory and analytical skills, societal issues in computing and telecommunication, and professional ethics. Gender issues in computer ethics are a specific focus.

In the summers of 2000, 2001 and 2002, DOLCE sponsored workshops that prepared computer science faculty to teach computer ethics using these materials to undergraduate students. Sixty-three faculty members from around the world either presented or attended these workshops. The participating teachers completed pre and post assessments before and after the summer workshops. Many of the participating faculty members' students were also evaluated using pre and post assessments before and after completing their computer ethics courses. This paper presents the design and the results of our assessment efforts for the last DOLCE workshop (2002). For further information concerning DOLCE see http://csethics.uis.edu/dolce/.

II. Project Goals

An overriding goal of the DOLCE project was to improve the instruction undergraduate computer science students receive with respect to computer ethics. In order to accomplish this goal, summer workshops were provided to college professors of computer science and related fields. These workshops were designed to prepare the college professors to teach a course or module concerning computer ethics and focused on both content and pedagogy. A total of three workshops were completed in the summers of 2000, 2001 and 2002. This paper will focus on the evaluation of the final DOLCE workshop (2002) and the following three project goals:

1. To increase faculty and students' awareness of ethical issues in computer ethics.
2. To increase faculty and students' content knowledge in computer ethics.
3. To increase faculty knowledge of how to teach and assess computer ethics.

We selected to focus this paper on the final DOLCE workshop, 2002, since evaluations from the 2000 and 2001 workshops led to revisions and improvements in the final workshops' implementation.

III. Project Design

A. Subjects

In 2002, fifteen faculty members from across the nation attended the DOLCE workshop. Nine of these individuals were women and six were men. Each of these faculty members expected to teach a computer science ethics module or course in the academic year 2002-2003. As part of project participation, faculty members agreed to ask their students to complete the pre and post Computer Ethics Attitudes survey and the pre and post Computer Ethics Content Assessment at the beginning and end of their course or module. All appropriate human subject procedures were followed with both the participating professors and the participating students.

B. Workshop Design

The 2002 workshop, held at the Colorado School of Mines in Golden, Colorado, began on a Sunday morning and ended the following Thursday afternoon. The workshop was designed to assist faculty in developing practical skills for teaching computer ethics to their students, as well as intellectual and emotional support for their own learning with respect to ethical issues. The face-to-face workshop activities included lectures, discussions, demonstrations, and opportunities for the participants to practice skills useful in teaching computer ethics. The faculty participated in role-playing exercises, simulated class sessions, and informal "bull sessions." Each participant also developed and delivered a fifteen minute sample lesson to other participants. These sample lessons ranged in design and included lectures, demonstrations and classroom discussions. The participants and leaders in the workshops spent considerable time sharing constructive criticisms of pedagogy and teaching materials.

Workshop topics, that concerned teaching, included how to organize a student discussion of an ethics case study (both in person and online), how to use analogies in teaching ethical material, issues in creating writing assignments, the principles of grading student essays, and how to pace student assignments during a course. There were also sessions focussing on content areas of computer ethics (e.g., ethical theory and privacy), gender issues (e.g., reasons for the low representation of women in computer science and the digital divide), and the societal impacts of computing (e.g., social analysis and the social impact statement). Participants were encouraged to examine their ideas about gender issues in computing, privacy in the workplace, computer ethics and the law, intellectual property, and bioinformatics; and then to transform this introspection into effective teaching designs to help students wrestle with these same issues. During lunch, participants could attend one of several different "birds of a feather" (BOF) sessions. These sessions allowed participants to select a topic within computer ethics and discuss this topic in greater depth with others that were interested in this topic. The BOF on gender issues proved especially productive, leading to the creation of a special issue for *Inroads* (the SIGCSE Bulletin) on women in computing[2]. A detailed schedule of project activities can be found at http://csethics.uis.edu/dolce/agenda02.html.

Before the workshop, the faculty were asked to complete two assessment instruments: the Computer Ethics Attitudes Survey and the Computer Ethics Content Assessment. After

completing both instruments, they were sent a copy of Deborah Johnson's textbook[3], *Computer Ethics*, and instructed to read this textbook prior to arriving in Golden.

C. Year Long Support

Throughout the 2002-2003 academic year, the participating faculty have had access to the investigators through our faculty liaison, Dr. Laurie King. Dr. King responds to faculty questions concerning the textbook, the web materials, the evaluations, and computer ethics issues. Dr. King also periodically verifies that the hyperlinks in the web materials are active.

D. Web Based Materials

The DOLCE project maintains a publicly accessible web site for teachers and students interested in computer ethics (http://csethics.uis.edu/dolce/). This site features teaching materials developed by workshop participants (http://csethics.uis.edu/dolce/teachsoft.html), links to other computer ethics sites (http://csethics.uis.edu/dolce/links.html), and a computer ethics contest for students (http://csethics.uis.edu/dolce/contest/contest.html).

IV. Assessment Methods

Both formative and summative evaluations were completed on DOLCE project activities. The focus of this paper will be on the summative assessment results from the academic year 2002-2003, i.e., the academic year after the last DOLCE workshop. These methods included an end of the Workshop Evaluation, a pre and post Computer Ethics Attitudes Survey, and a pre and post Computer Ethics Content Assessment. Each is described in the sections that follow. The next section of this document (Section V) presents the assessment results and this is followed by a discussion of those results (Section VI).

A. Workshop Evaluation

At the conclusion of each summer workshop, participating professors were asked to complete a Workshop Evaluation. The purpose of this instrument was to determine the extent to which the participating faculty perceived the workshop to be useful. This instrument consisted of four selected response questions and one open ended question. The selected response questions for the 2002 workshop are shown in Table 1. The selected response categories were, "No Increase", "Slight Increase" and "Significant Increase" in understanding. The open response question was as follow, "If you have any recommendations as to how we can improve this workshop, please write them in the space below and on the back of this page." Recommendations from the 2000 and 2001 workshops helped us organize the 2002 workshop.

B. Computer Ethics Attitudes Survey

The Computer Ethics Attitudes Survey is an on-line assessment developed through a collaborative effort by the project investigators and the assessment specialist. This instrument was designed to determine whether the participating faculty members and their students' attitudes concerning the importance of computer ethics changed as a result of project activities.

The Computer Ethics Attitudes Survey was administered to participating faculty before and after the summer workshop. This same survey was administered to the students of the participating faculty before and after taking a given computer ethics course or module.

The first question on the attitude survey requested the respondent rank ten different computer science courses in order of importance. A "1" indicated the most important course while a "10" indicated the least important course. The listed courses were: Artificial Intelligence, Data Structures, Database, Distributed Computing, Ethical Issues in Computing, Finite Automata, Graphics, Operating Systems, Software Engineering, and Testing and Reliability.

The second set of questions on the attitudes survey were based on the following scenario:

You work at a software development company, and your company is working on a program that will control an anti-lock braking system for a pick up truck. This software is a considerable advance over previous versions, and will make the brakes even more effective on slippery surfaces. Your main duty is to receive data from software quality control engineers and produce reports for managers about the progress of software testing. While you are producing this month's report, you think there are some discrepancies in the data reported. You discuss your misgivings with the engineer who gave you the data, and he suggests you talk to the department head. You talk to the department head, and she assures you that the data is correct, and asks you to please finish the report as soon as possible. The department head reminds you that she has an advanced degree in computer science (you do not), and that she sees nothing wrong with the data. You are still unconvinced, and worry that the data may hide flaws in the software testing results so far and could lead to consumer injuries. You are considering taking the issue to your department head's boss, who also has an advanced degree in computer science.

The respondents were asked to imagine they are in this situation. They are then presented with a list of 12 reasons that support either going or not going to the department head's boss. Respondents were asked to rank the extent to which each of the presented reasons would influence their final decision using the following categories: "No impact on my final decision", "Slight impact on my final decision", "Strong impact on my final decision", and "Very strong impact on my final decision". The list of reasons that were provided is displayed in Table 2.

The final question on the attitude's survey asked the respondents to imagine they were in charge of a new NSF division and had the opportunity to award $1,000,000 in grants. Proposals of similar quality were submitted in the following areas: Algorithms, Artificial Intelligence, Commercial Off-The-Shelf Software, Databases, Formal Methods in Computer Science, Image Processing, Networking, Programming Languages, Robotics and Social and Ethical Issues in Information Technology. Assuming the same number of grant applications were submitted from

each area, participants were asked to determine how much of the 1,000,000 should be awarded to each area.

C. Computer Ethics Content Assessment

The Computer Ethics Content Assessment is an on-line multiple-choice assessment developed with the specific purpose of addressing content issues within computer ethics. This instrument consists of 25 questions and was developed to correlate with Deborah Johnson's[3] textbook, *Computer Ethics*. The specific questions that comprise this instrument were created through a close collaboration of the project investigators and the assessment specialist. The resultant instrument can be found at http://csethics.uis.edu/dolce/assessment/EthicsAssessment.html.

The Computer Ethics Content Assessment was administered to participating faculty immediately before and immediately after the summer workshop. Students completed the Computer Ethics Content Assessment immediately before and after completing a course or module that concerned computer ethics.

V. Assessment Results

This section is divided into three subsections. The first section describes the faculty members' responses to the Workshop Evaluation. This is followed by a summary of the results of the pre and post assessments completed by both faculty and their students.

A. Workshop Evaluation

Of the fifteen faculty members participating in the summer workshop in 2002, fourteen completed the Workshop Evaluation. The number of faculty members responding to each question within a given response category is shown in Table 1.

The final question on this survey concerned recommendations for improving the summer workshop. Only three respondents made suggestions concerning how to improve the content or presentation of the workshop. These were as follows:

- Extend the amount of time for sample lessons.
- Provide more time for participants to interact.
- Extend the discussion of legal issues.

Many of the respondents provided positive comments with regard to the workshop. These included the following:

- Good job.
- You have creative ways to engage me in the learning activities.
- Everything about the program was top notch.
- WORKSHOP WAS FABULOUSLY WELL DONE.

Question	No Increase	Slight Increase	Significant Increase
1. To what extent has your understanding of computer ethics increased as a result of participating in this workshop?	0	4	10
2. To what extent has your understanding of how to teach computer ethics increased as a result of participating in this workshop?	0	2	12
3. To what extent has your understanding of how to assess a student's work in computer ethics increased as a result of participating in this workshop?	0	4	9
4. To what extent has your understanding of how to use the Web when teaching computer ethics increased as a result of participating in this workshop?	5	7	2

Table 1. Results of Selected Response Portion of the Workshop Evaluation

B. Computer Ethics Attitudes Survey

Out of the fifteen faculty members participating in the DOLCE 2002 summer workshop, fourteen completed both the pre and post attitudes survey. Due to the small number of faculty participants, only summary statistics are presented for this group. Fifty-one students in the participating faculty's classrooms also completed both the pre and post attitudes survey. Statistical comparisons of these students' responses are presented in this section.

As was discussed earlier, the first question on the attitude's survey concerned ranking a list of courses in order of importance. The course "Ethical Issues in Computing" had an average ranking by participating faculty of 5.07 on the pre-assessment and 4.36 on the post-assessment. In other words, participating faculty ranked the course Ethical Issues in Computing as slightly more important after the workshop. A similar result was found for students. Students had ranked Ethical Issues in Computing on average as 6.02 on the pre-assessment and 5.18 on the post-assessment. Using a one-tailed paired t-test, this was found to be a statistically significant change from pre to post assessment with $p=.02$.

In the next set of questions, the respondents were asked to indicate the extent to which a given set of reasons would influence their final decision with respect to the presented scenario. For analysis purposes, the phrases "No impact on my final decision", "Slight impact on my final decision", "Strong impact on my final decision" and "Very strong impact on my final decision" were mapped to the values "1","2", "3" and "4", respectively. A higher value indicates stronger agreement with a given statement. Table 2 presents the average score across faculty and students for the pre and post assessment for each reason. Results found to be statistically significantly

	Faculty		Students	
Reason	Pre	Post	Pre	Post
i. The software will improve anti-lock brakes to make them safer.	2.57	3.07	2.82*	3.14*
ii. I don't want to lose my job for doing the wrong thing.	2.36	2.21	2.18	2.33
iii. My organization has an obligation to deliver on its promises.	2.5	3.36	2.67	2.67
iv. Since I don't have the experience, I need to rely on the experience and recommendations of others.	2.43	2.36	2.43	2.41
v. I would rather avoid being blamed for any trouble that might result.	2.00	1.93	2.26	2.12
vi. If I make the right decision, I will be more likely to be promoted.	1.50	1.71	2.05	2.00
vii. It's my job to do what most benefits the organization.	2.29	2.43	2.39	2.24
viii. People involved in software testing have a responsibility to protect the public.	2.79	3.36	3.20	3.35
ix. If I make the right decision, my job performance evaluation will be very positive.	1.64	1.71	2.24	2.08
x. I should follow whatever advice I get from the code of ethics for computer scientists.	1.93	1.79	2.22*	2.61*
xi. It is most important for me to follow the company's rules about who makes what decisions.	1.64	1.57	2.26	2.09
xii. We should be concerned about the safety of the people who will drive the pick up trucks.	3.50	3.57	3.24*	3.53*

Table 2. Teacher and students' average scores with respect to a given reason
Note: * indicates statistical significance for α=.10.

different from the pre to the post-assessment for α=.10 based on a two tailed paired t-test are marked with an asterisk. The reader is reminded that statistical comparisons were only made between student responses from pre to post assessment and not faculty responses due to sample size.

The final question on the attitude's survey asked respondents to allocate $1,000,000 to various areas of computer science. It was anticipated that more money would be allocated to "Ethical Issues in Information Technology" after faculty members participated in the workshop and after students had participated in the course or module concerning computer ethics. The average amount of money allocated to Ethical Issues in Information Technology by the faculty on the pre-assessment was $155,400 and on the post-assessment was $179,600. The average amount of money allocated to this area by students on the pre-assessment was $85,600 and on the post-assessment was $103,400. Using a one-tailed paired t-test on the student responses, a statistically significantly difference was found with p=.04.

C. Computer Ethics Content Assessment

Nine of the participating faculty and 46 of their students completed both the pre and post content assessment. Due to the small sample size with respect to faculty, only descriptive statistics will be provide for faculty responses.

Each of the 25 questions on the content assessment was scored as either correct or incorrect. The average percent correct across respondents was then compared. On average, faculty members answered 19.89 of the pre-assessment questions correctly and 20.44 of the post-assessment questions correctly. Students on average answered 12.28 of the pre-assessment questions correctly and 16.63 of the post-assessment questions correctly. The difference between students' pre and post responses was found to be significantly different based on a one-tailed paired t-test with α=.05 (p=.00).

VI. Discussion

Overall, the results of the evaluation of the 2002 DOLCE project are encouraging. Based on the Workshop Evaluation, participating faculty collectively expressed that the workshop had reached its goals of helping faculty better understand computer ethics and how to teach computer ethics. The first three questions on this survey (see Table 1) addressed these areas and the majority of respondents indicated they had experienced a significant increase in these areas. In other words, the participating faculty evaluated the project as having reached the project goals.

The final question on the selected response section of the Workshop Evaluation asked respondents to rate the extent to which their understanding of how to use the web to teach computer ethics had been impacted by project activities. The majority of the faculty reported they believed participation in the summer workshops had slightly increased their understanding of how to use the web when teaching computer ethics. In order to better understand the faculty responses to the fourth selected response question, further details concerning earlier workshops are needed. During the 2002 workshop, the web component had been purposefully de-

emphasized based on recommendations made by workshop participants in 2000 and 2001. These earlier participants expressed a desire to spend more workshop time on computer ethics content and pedagogy and less time on web based materials. They supported this recommendation with the argument that they could easily explore the web based materials on their own. In response, during the 2002 workshop the web based materials were introduced, but were not fully explored. Instead, the faculty liaison reminded the participants of these resources via e-mail during the academic year that followed. In other words, the bulk of participants' development of knowledge of web based materials took place after the administration of the Workshop Evaluation.

The next component of the assessment activities was the administration of the pre and post Computer Ethics Attitudes Survey. This instrument was designed to measure project goal #1, "To increase faculty and students' awareness of ethical issues in computer ethics." On the first question, on average both the faculty and students ranked "Ethical Issues in Computing" as being of greater importance on the post assessment than on the pre assessment. Similarly, on the post-assessment both the faculty and the students allocated more money to "Ethical Issues in Information Technology" than they had on the pre assessment. For the students, these changes were statistically significant. As was previously stated, a statistical comparison between pre and post assessments could not be made for faculty due to the small sample size. Both of these differences suggest that the faculty and students placed greater value on computer ethics after participation in the DOLCE project.

The middle portion of the attitude's survey presented a scenario and asked the respondents to rate the extent to which a list of reasons would impact their decision making process with respect to the scenario. The presented reasons are shown in Table 2. These reasons were designed to reflect three different levels of moral development as described by Kohlberg[4]. Statements *ii*, *v*, *vi*, and *ix* are at the most basic level, which Kohlberg called “pre-conventional.” Statements *iv*, *vii*, *x*, and *xi* are at a more advanced level, “conventional.” The highest level, which Kohlberg called “post-conventional,” is represented by statements *i*, *iii*, *viii*, and *xii*.

For students, two of the questions that reflected Kohlberg's highest level of moral development displayed a statistically significant change from pre to post assessment. These were reason *i*, "The software will improve anti-lock brakes to make them safer", and reason *xii*, "We should be concerned about the safety of the people who will drive the pick up trucks." The fact that students scored these two reasons significantly higher after their DOLCE experience is greatly encouraging. Faculty ratings also increased from pre to post assessment on these reasons. These changes suggest that both faculty and students had an increased awareness of the link between technical decisions and the safety of those using the resultant products after project participation. Further support for this claim can be found in the increase that is witnessed for both faculty and students from pre to post assessment (although not statistically significant) for reason *viii*. Thus, for three of the four statements designed to reflect Kohlberg’s highest level of moral reasoning, on average, both faculty and students ranked these statements as more important after their DOLCE experience.

Only one of the remaining reasons displayed a significant change on average for students from pre to post assessment. This was reason *x*, "I should follow whatever advice I get from the code of ethics for computer scientists," and it lies in Kohlberg's middle level of moral reasoning. Based on

averages, students were more likely and faculty were less likely to rely on the ethical code for computer scientists after instruction. This inconsistency between faculty and student responses with respect to this reason may suggest that maturity and experience influence the outcomes of computer ethics education. As a result of computer ethics instruction, students may develop a greater trust in the computer ethics community while faculty develop a greater trust in their own ethical decisions.

Although none of the remaining student rankings changed significantly from pre to post assessment, there were some interesting patterns that emerged. For example, the rankings for reasons *iv*, *v* and *xi* decreased from pre to post assessment for both faculty and students. Reason *v* was designed to reflect Kohlberg's lowest level of moral development while reasons *iv* and *xi* were designed to address Kohlberg's middle level of moral development. Each of these reasons addressed the respondents' acceptance of personal responsibility for ethical decision making. The witnessed decrease from pre to post assessment suggests that the participants were more willing to accept personal responsibility for their ethical decision making after project participation. Further support for this claim is provided by the observation that both faculty and students displayed an increase from pre to post assessment with respect to reason *viii*. This question directly addresses the personal responsibility of individuals involved in software testing.

Other rankings within this grouping on the attitude's survey had mixed results. For example, faculty were less concerned while students were more concerned about losing their jobs (*ii*) because of an ethical decision after project participation. Faculty also displayed an increased belief after project participation that making the right decision would have a positive impact on their careers (*iv* and *ix*); The reverse was true for students. As was previously discussed, conflicting results between student and faculty outcomes may suggest that maturity and experience may be important factors in determining the effects of computer ethics education. The causes of these differences span beyond the scope of this paper and are left for future research.

The final assessment instrument used was the Computer Ethics Content Assessment. This instrument was specifically designed to measure goal #2, "To increase faculty and students' content knowledge in computer ethics", and to be consistent with Johnson's[3] textbook. Both participating faculty and students displayed an increase in their average score from pre to post assessment. Additionally, the student difference was found to be statistically significant. This was an especially exciting result for the developers of the DOLCE workshop. Often the intention of faculty workshops is to have a positive impact on the instruction of students. However, measuring this change is difficult because it requires the cooperation of many different classrooms. Because we had the cooperation and support of the faculty participants, we were able to demonstrate the positive impact the workshop had on participants' students.

The purpose of this paper is to present the design and assessment of the 2002 DOLCE workshops. This final workshop had been developed based on the assessment efforts of the previous workshops and the feedback that had been provided by previous participants. As the results suggest, DOLCE has been successful in increasing both students and faculty's knowledge of computer ethics. It is our hope that future projects will use our materials and instruments and benefit further from these experiences.

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