Does ACM's Code of Ethics Change Ethical Decision Making in Software Development?

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ABSTRACT

Ethical decisions in software development can substantially impact end-users, organizations, and our environment, as is evidenced by recent ethics scandals in the news. Organizations, like the ACM, publish codes of ethics to guide software-related ethical decisions. In fact, the ACM has recently demonstrated renewed interest in its code of ethics and made updates for the first time since 1992. To better understand how the ACM code of ethics changes software-related decisions, we replicated a prior behavioral ethics study with 63 software engineering students and 105 professional software developers, measuring their responses to 11 ethical vignettes. We found that explicitly instructing participants to consider the ACM code of ethics in their decision making had no observed effect when compared with a control group. Our findings suggest a challenge to the research community: if not a code of ethics, what techniques *can* improve ethical decision making in software engineering?

CCS CONCEPTS

• **Social and professional topics → Codes of ethics**;

KEYWORDS

ACM code of ethics, software engineering

1 INTRODUCTION

Software developers must constantly make ethical considerations, including deciding the proper amount of user data to collect; balancing added functionality with potential adverse environmental effects; and performing due diligence to reduce the risks of critical security bugs. Such ethical decisions can cause substantial harm to people, to organizations, and to our planet. Consider two recent examples.

The first example is the Uber versus Waymo dispute [26], in which a software engineer at Waymo took self-driving car code to his home. Shortly thereafter, the engineer left Waymo to work for a competing company with a self-driving car business, Uber. When Waymo realized that their own code had been taken by their former employee, Waymo sued Uber. Even though the code was not apparently used for Uber's competitive advantage, the two companies settled the lawsuit for $245 million dollars.

The second example is the "Dieselgate" scandal [21], where software inside certain diesel Volkswagen vehicles was programmed to run in one of two modes. In one mode, the car operated under normal, day-to-day driving conditions, but emitted pollution at levels above what is allowed by US and international regulators. In the other mode, the car emitted allowable pollution levels, but only when it detected that it was being inspected by regulators. Although software engineers raised objections to management about the devices, they did not bring these concerns to authorities [19]. Consequently, the company was forced to pay $30 billion dollars in compensation so far [31] and an estimated 59 people suffered early deaths as a result of the excess emitted pollution in the US alone [5].

As early as 1913, organizations have published codes of ethics to guide people facing such ethical situations [3]. In 1972, the Association for Computing Machinery (ACM) adopted a code of ethics designed to specifically to apply to software development. In 2018, the ACM code of ethics was updated for the first time since 1992 [2]. In light of recent software ethics scandals, like Dieselgate and the Uber versus Waymo dispute, and ACM's renewed interest in revising its guidelines, we are motivated to study the effect of ACM's code of ethics on ethical decision making in software development. While the ACM claims its code of ethics is "intended to serve as a basis for ethical decision making" [1] to our knowledge the effectiveness of this claim has never been tested.

We asked 63 software engineering students and 105 professional software engineers to consider 11 software-related ethical decisions. We derived these decisions from real ethical dilemmas faced by software developers. To assess how much the ACM code of ethics influenced decision making, participants were divided into two groups, a control group, and a group explicitly instructed to use the ACM code of ethics. The primary contribution of this paper is a better understanding of ethical decision making in software development and the influence of the ACM code of ethics on those decisions.

2 RELATED WORK

Researchers have postulated that many variables can influence ethical decision making [11]. Here we focus on the most relevant work pertaining to codes of ethics, including what their purposes are,

the effectiveness of codes in organizations, and how ethics affect Information Technology professionals.

Purpose of codes of ethics: Wood and Rimmer comment that codes of ethics have become popular because they are a way for organizations to appear ethical while also noting that the codes can be a useful starting block when working towards ethical behavior in market decisions [36]. That being said, there are several organizational benefits that come with having a code of ethics including clarifying management's thoughts about what is ethical, providing employees with a way to think about ethical issues before they arise as well as a reason to decline performing unethical actions, and assisting in training employees [24]. The ACM provides some guidance on how they intend that the code of ethics should be used, namely to serve as a basis for ethical decision making [1].

Effect of codes of ethics in organizations: Researchers have been interested in identifying whether these codes affect the decisions of employees. Prior research agrees that there are many different factors involved in making ethical decisions [18] including individual characteristics (i.e., cognitive moral development [33], moral philosophies [4, 12], job satisfaction [10, 17]), characteristics of the moral issue (i.e., proximity, magnitude of the consequences, temporal immediacy) [22, 25, 28], and organizational characteristics (i.e., code of ethics, ethical climate [9, 35]).

Prior studies have measured whether codes of ethics have effects on ethical decisions made in other domains by examining simulated decisions. Several of these studies have found fewer unethical decisions are made in the presence of a code [15, 16, 23, 27, 30, 34], but other studies have found no significant effect [7, 8].

Ethics in Information Technology: While most ethics research has assessed decision-making factors for managers and businesses, little has specifically investigated ethics within computing. Harrington found that codes of conduct have little effect preventing Information Systems (IS) employees from misusing computing resources including cracking computing systems, sabotaging competitors' security, writing viruses, and conducting bank fraud while denial of responsibility had a larger effect [14]. Similarly, Thong and Yap studied entry-level IS professionals' decisions about whether to illegally copy software for personal use [32]. In contrast to these studies that examine the decisions of people who *use* software, ours examines the decisions of those who *create* software.

Peslak investigated students' level of agreement with select statements in the 1992 ACM Code of Ethics [29]. Our study builds on Peslak's work by investigating whether exposure to the ACM code of ethics influences ethical decision making.

3   METHODOLOGY

Since the ACM claims that its code of ethics is "intended to serve as a basis for ethical decision making," we decided to test whether that claim holds up in practice:

Does the presence of a code of ethics influence software-related ethical decisions?

To answer this question, we performed a conceptual replication (or a reproduction, according to Gómez and colleagues' classification [13]) of a study by Cleek and Leonard [8]. Our methodology

parallels Cleek and Leonards' in the sense that in both studies participants were asked to make decisions about ethical vignettes. Rather than recruiting business students, we instead recruited software engineering students and professionals. Additionally, we improved upon Cleek and Leonards' methodology by instrumenting student participants' questionnaire to determine whether they read the code of ethics.

In our study, we present participants with vignettes derived from real-world ethical situations in software development. We asked participants to decide how they would act in each situation and compare the decisions made by participants who were given the ACM code of ethics to a control group of participants who saw no code of ethics. In the remainder of this section, we describe our study design, including how we selected vignettes to present to participants. In Section 3.2, we discuss how we analyzed our results.

3.1   Study Design

3.1.1   Identification of Ethical Issues. To identify ethical issues in software development, we first conducted two rounds of exploratory pilot interviews, each with three software engineering researchers. In the first round, we simply asked individuals to recall instances where they made software-related ethical decisions. In the second round of interviews, we attempted to elicit responses by discussing each principle of the ACM 2018 Code of Ethics, Draft 1.[1] Based on these interviews, we determined that software participants 1) might not be able to recall ethical decisions they made in the workplace 2) may not be comfortable discussing situations where they personally had to make ethical decisions during face-to-face interactions with a researcher.

Since participants did not openly discuss their own personal ethical decisions, we therefore decided to identify real-world issues posted to online forums and discussed in the literature. First, we searched the Software Engineering Stack Exchange[2] for posts tagged with "ethics" on November 2, 2017. We removed the posts that did not present an ethical issue. Many of the remaining posts either covered related topics or were duplicates. To remove duplicates and identify more general patterns of ethical issues, two authors clustered the remaining 82 posts. This process resulted in the creation of six general clusters (examples from each cluster given as footnotes): *responsibility to report,*[3] *user data collection,*[4] *intellectual property,*[5] *code quality,*[6] *honesty to customer,*[7] and *personnel and time management.*[8]

Based on the Stack Exchange posts in each cluster, we derived two vignettes describing situations similar to the situation in the posts. Due to the breadth of topics reported related to intellectual property, we included five vignettes in that cluster, for a total of 15 vignettes from the Stack Exchange posts. Each vignette included two possible actions the reader might take, these two choices were also based on the content of the Stack Exchange posts. To increase our

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[1]https://ethics.acm.org/2018-code-draft-1
[2]https://softwareengineering.stackexchange.com
[3]http://softwareengineering.stackexchange.com/questions/97724
[4]http://softwareengineering.stackexchange.com/questions/114289
[5]http://softwareengineering.stackexchange.com/questions/8758
[6]http://softwareengineering.stackexchange.com/questions/147816
[7]http://softwareengineering.stackexchange.com/questions/168013
[8]http://softwareengineering.stackexchange.com/questions/184909

coverage of possible topics, we also adapted the six vignettes used in Cleek and Leonard's study of corporate codes of ethics [20]. Two of the 21 vignettes we identified resemble the two motivating examples described in Section 1 (Waymo dispute and Dieselgate). We are particularly interested in these vignettes, because they represent high-impact, real-world ethical dilemmas.

3.1.2 Selection of Ethical Issues. To get feedback on our 21 vignettes and select which vignettes should be included in the final study, we distributed the vignettes to a convenience sample of 9 software engineering graduate students. These participants responded to each of the ethical decisions and were also given the opportunity to comment on each vignette.

We used the following inclusion criteria to construct our final set of vignettes:

(1) Keep the Waymo- and Diselgate-like vignettes to test whether prior knowledge of high-profile ethical dilemmas changes decision-making
(2) Keep one question per Stack Exchange cluster considering, with highest priority criteria first:
  (a) Variance among pilot study responses — *we argue that when dilemmas are easy, participants make the obvious choice without the need for a code of ethics*
  (b) The clearest scenarios, according to pilot participants
  (c) The brevity of the scenario description — *in order to limit the load on participants, we preferred shorter scenarios as a tie-breaker*
(3) Three vignettes from Cleek and Leonard, selected according to the previous criteria

As a result, we selected 11 vignettes to include in the final study.

3.1.3 Study Protocol. Consistent with Cleek and Leonard [8] and based on the discomfort that we observed during face-to-face pilot interviews, we decided to conduct the study remotely by distributing a questionnaire.

First, the questionnaire described a fictional company that the participant had just joined as a Lead Developer. Next, participants were randomly assigned to one of two conditions:

- About half of the participants were simply told that the backbone of the company culture was strong ethical standards. (*n* = 34 students, *n* = 56 professionals)
- The other half were told that the backbone was the ACM Code of Ethics. This second group of participants were shown a brief version of the ACM 2018 Code of Ethics (*n* = 29 students, *n* = 49 professionals)[1]

All participants were asked to open a link to the background information about the company in a separate tab for reference. For participants in the second group, this page also included the full ACM Code of Ethics.

We presented participants with the 11 vignettes, one at a time, in a randomized order. Figure 1 depicts what participants encountered for one of these vignettes. Participants were then asked to, "respond to whichever answer best describes the way in which you would act in the particular situation." Participants could select between two options, or specify that they were unsure. After the participants

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[1]Because the final version of the code was not yet available when we conducted our study with students, for students we used Draft 2 (https://ethics.acm.org/2018-code-draft-2).

> A deadline is quickly approaching for a project that you are working on. You realize that you will not be able to meet the deadline if you only work during normal hours. You are not allowed to take your computer out of the office. What do you do?
>
> ○ Download the data on a personal hard drive so you can continue development at home
> ○ Unsure
> ○ Stay at work longer in order to continue development

Figure 1: Intellectual property (*Waymo*) vignette

responded to all of the vignettes, we collected basic demographic information.

A full replication package, including the background briefings, 11 vignettes, and options presented to participants is provided in the Supplemental Materials.

3.1.4 Participants. After the final set of ethical issues were selected, we distributed the IRB approved protocol to undergraduate students, then later to a set of professional software developers.

For student participants, we recruited from a third-year software engineering course. In order to increase participation, the instructor for the course awarded extra credit on a course project for completing the study. 63 student participants completed the study. Most participants were 20-25 years old. Of the 29 participants that were familiar with the ACM before the study, 24 of them knew that the ACM had a code of ethics. Additionally, 59 individuals reported believing that ethical behavior is either definitely or probably important for success in an organization.

For professional participants, we paid Qualtrics Research Services[2] $4000 USD to recruit software developers in the U.S. that had 5 years of experience or more. Responses were excluded from analysis if a participant either (a) provided nonsensical or irrelevant responses to free form questions, or (b) completed the survey too quickly, with a cutoff of one third median completion time, as defined by pilot run with professional developers. 105 professionals completed the study, most over 40 years old. Of the 51 participants that were familiar with the ACM before the study, 39 knew that the ACM had a code of ethics. 100 reported that ethical behavior is either definitely or probably important for success in an organization.

3.2 Analysis

3.2.1 Data Collection. The primary measure we collected was participants' responses to each of the 11 vignettes. There were three possible responses for each vignette; participants could choose between two actions or indicate they were unsure. To ensure participants in the Code of Ethics condition read the code, we instrumented the website where it was hosted. We measured the time each participant spent on the website and collected click-based data, which revealed that participants interacted with the website. We used instrumentation only with students; we judged that this would be more challenging with professionals for privacy reasons.

3.2.2 Data Analysis. To determine whether participants who viewed the ACM Code of Ethics made different decisions compared with those in the control group, we analyzed the variance between responses in the two conditions. Since the vignette decisions are not

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[2]https://www.qualtrics.com/research-services/

Table 1: Vignette response counts

		Students			Professionals		
Vignette	**Condition**	**A**	**?**	**B**	**A**	**?**	**B**
Cleek & Leonard	CoE	10	1	18	17	4	28
#2	Control	10	7	17	11	3	42
Cleek & Leonard	CoE	5	1	23	21	1	27
#3 (*Dieselgate*)	Control	7	3	24	21	3	32
Cleek & Leonard	CoE	20	4	5	31	10	8
#4	Control	19	4	11	34	9	13
Cleek & Leonard	CoE	14	2	13	33	5	11
#6	Control	19	2	13	38	0	18
Responsibility	CoE	23	1	5	35	5	9
to report	Control	23	1	10	33	4	19
User data	CoE	8	6	15	15	5	29
collection	Control	15	7	12	22	8	26
Intellectual	CoE	13	6	10	35	5	9
property	Control	16	10	8	28	8	20
Intellectual	CoE	0	2	27	5	3	41
property (*Waymo*)	Control	1	1	32	6	3	47
Code	CoE	19	6	4	32	8	9
quality	Control	23	3	8	30	11	15
Honesty to	CoE	12	5	12	25	5	19
customer	Control	13	3	18	27	4	25
Personnel and	CoE	5	2	22	11	3	35
time management	Control	3	5	26	16	3	37

normally distributed, we used the Kruskal-Wallis Rank Sum Test with the null hypothesis that decisions are the same between the two conditions (α = .05). Since we would be running this test once per vignette, we controlled for false discovery using a Benjamini-Hochberg correction [6].

4 RESULTS

We compared the distribution of responses from participants under the Code of Ethics condition to the distribution of participants' responses in the control group to answer our research question:

Does the presence of a code of ethics influence software-related ethical decisions?

No statistically significant difference in the responses for any vignette were found across individuals who did and did not see the code of ethics, either for students or for professionals. While all participants who were in the "code" condition saw a brief version of the ACM Code of Ethics in the background section of the questionnaire, the full code was not available to participants unless they opened the external website in a new tab. Therefore, we re-ran the tests only considering those students who had either opened the code of ethics in another tab or remained on the project description for at least thirty seconds. Even with these more strict inclusion criteria (which removed two people from the "code" condition), there was no significant difference.

Table 1 summarizes responses under both conditions, those who viewed the Code of Ethics (CoE) and those in the control group (Control), for each vignette. For example in the CoE condition,

responding to the Intellectual property (*Waymo*) vignette: 0 students selected option A ("Download the data on a personal hard drive so you can continue development at home"); 2 students were unsure; and 27 selected option B ("Stay at work longer in order to continue development"). Comparatively, in the control group for the same vignette: 1 student selected option A; 1 was unsure; and 32 selected option B. The rightmost three columns show similarly proportioned response counts for professional participants.

The data also allows us to answer the follow-up question:

Does awareness of news stories influence software-related ethical decisions?

Since two of the vignettes were based off of recent news stories (Dieselgate and the Waymo dispute), after the questionnaire we provided the opportunity for participants to indicate whether they recognized news stories. None of the participants indicated that they recognized the Waymo dispute, however, 19 students (30%) and 1 professional (1%) specifically mentioned the Dieselgate scandal. We tested to see if students who recognized the Dieselgate news story made different decisions. We found that students who did not mention the Dieselgate incident were more likely to indicate willingness to create test-evading software (p = .013). In fact, none of the students who recognized the story indicated they would build the cheat software. Perhaps this suggests that one effective way to influence ethical decision making in software development is to help developers see the connections between the consequences of their decisions and examples of similar news-worthy decisions.

5 THREATS TO VALIDITY

Since the vignettes, as presented, do not fully qualify the situations (i.e., what measures have previously been taken or what other options are available), participants might prefer to remain undecided about what decision to take. Furthermore, to enable us to compare response between individuals, we had to constrain the choices for each vignette. Our questionnaire only presents two possible actions for each vignette (along with an "unsure" option). Decisions in these situations rarely have only two available actions, therefore, some participants might be unsure what they would do because they would really do *neither* of the options presented.

Our ability to detect statistically significant differences is limited by study sample size. More participants may yield significant results.

Finally, our questionnaire measures participants' intentions, rather than their actual ethical decisions. Using intention as a proxy for behavior is common in behavioral ethics research [18]. Further, this design choice was necessitated by our pilot participants' reluctance to discuss ethical dilemmas in which they had been directly involved.

6 CONCLUSION

We investigated the ACM code of ethics' effect on software-related ethical decisions. Despite its stated goal, we found no evidence that the ACM code of ethics influences ethical decision making. Future research is required to identify interventions that do influence decision making, such as by helping developers identify parallels between their decisions and infamous software news stories.

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SUPPLEMENTAL MATERIAL

Introduction

You are about to begin a series of decision-making scenarios, and you are asked to respond to whichever answer best describes the way in which you would act in the particular situation. You may not have enough information to fully support your decisions, but please do your best to report what you would most likely do. If you need to state some assumptions, you may do so on each question.

Background

- Assume that you have just begun working in the software development department for a medium size technology company, and that they were now the Lead Programmer, that is, someone who has both management and programming responsibilities.
- The company is in good financial standing, and is maintaining a moderate competitive position (unless otherwise stated).
- Although international competition is strong, the company hopes to improve its global presence.
- The company strives to maintain a strong organizational culture, the backbone of which are high ethical standards.

Vignettes

The vignettes below were displayed one at a time in a random order to all participants. The selections for each question were also randomized. A heading has been added to each vignette here for clarity.

Volkswagen Emissions (also Cleek and Leonard). The manufacturing department has developed a new technology to enable a specific feature that users have been requesting for a long time. Unfortunately, the technology cannot operate without causing the electromagnetic fields of cell towers to increase beyond the legal limits. While this functionality has not been possible for the last several years, if you wait until you can get within the legal limits, competitors would very likely beat you to the market. A manager suggests to change the device's software to detect when regulatory testing is happening and modify its behavior to prevent the electromagnetic field increases. What do you do?

- Begin development of the test-detection software
- Unsure
- Wait for the technology to be available without test-detection software and risk being beaten to market

Uber/Waymo intellectual property. A deadline is quickly approaching for a project that you are working on. You realize that you will not be able to meet the deadline if you only work during normal hours. You are not allowed to take your computer out of the office. What do you do?

- Download the data on a personal hard drive so you can continue development at home
- Unsure
- Stay at work longer in order to continue development

Responsibility to report. Your company is struggling to enter a lucrative market dominated by a single competitor. When trying to figure out how to import data from that competitor's website, you discover a severe 0-day vulnerability which would allow an exploiter to easily access all of the competitor's customers' information. What do you do with the information about the bug?

- Report the information to the competitor
- Unsure
- Say nothing about the information to the competitor

User data collection. Your company has been collecting anonymous usage statistics for their products for many years, but have recently been struggling to acquire new users, causing the company to consider scaling down operations. Seeing your company struggle and knowing the value of its customer data, an advertising company approaches you to use your company's user data to improve their ad recommendations. Your privacy policy does not explicitly mention selling user data to others, but turning down this offer may result in employees being fired. You are in charge of this decision; what do you do?

- Sign a contract with the advertising company
- Unsure
- Decline the offer with the advertising company

Intellectual property. In order to protect against unauthorized use of your software, your company has built in an automatic kill switch that prevents it from running after a specific amount of time. An intensive care unit at the local hospital started using your software a year ago. The unit hasn't paid any of their bills and the kill switch is about to trigger. If the kill switch remains in place, the hospital will not be able to function as critical equipment will be disabled. You are capable of removing the kill switch for the hospital. What do you do?

- Edit the software to remove the kill switch
- Unsure
- Do nothing, allowing the kill switch to activate

Code quality. In going over a software specification that your company has just been hired to create, your team discovers a large flaw that could potentially affect the customer. Your company has spent the last year trying to negotiate this lucrative contract and your managers do not want to tell the customers about the issue because it might extend the negotiations even further. What do you do?

- Tell the customer about the issue
- Unsure
- Do not tell the customer about the issue

Honesty to customer. You are on a team that is charged with maintaining critical software for a customer's financial system. During testing, you discover a critical bug that has been present for a long time. While you fix it quickly, your manager does not want to inform the customer for fear that they might doubt your company's competence. What do you do?

- Tell the customer about the bug
- Unsure
- Do not tell the customer about the bug

Personnel and time management. You have been the point of contact within your company for all projects related to a specific customer. One day, you get a message in your personal email from that customer requesting your services to get paid as a contractor on a project completely unrelated to all of the prior work they have requested with the company. What do you do?

- Accept the work from the customer
- Unsure
- Notify your manager about the request

Cleek and Leonard #2. Your former employer is rumored to be the leader for a new software product which might be a breakthrough in the industry. The morning beginning your third week at your present job, you receive the following memo from the president:

> Please meet with me tomorrow at 8:15 for the purpose of discussing the developments your former employer has made in this new area

What do you do?

- Tell the president you will not discuss the issue
- Unsure
- Meet with the President knowing the purpose of the discussion

Cleek and Leonard #4. The company is currently being sued by a customer who is claiming that he was injured by one of the company's products. When your development duties take you to a part of your company's open sourced code that has not been looked at in years, you find a corner case that might affect the customer's personal injury claim. There is a large sum of money at stake and the company is currently in good shape to win the case. What do you do?

- Reveal the information to the customer
- Unsure
- Not reveal the information to the customer

Cleek and Leonard #6. As you leave your office for an extremely important project pitch with a major potential new customer, you overhear the administrative assistant saying,

> If Joe calls in, please see that he calls home, as his spouse says there is a mini-crisis.

You are to meet with Joe at the customer's office, and the two of you are to make the pitch. Joe's participation is critical. Joe is quite nervous and often gives a bad impression if distracted. What do you do?

- Relay the information to Joe before the meeting
- Unsure
- Not relay the information to Joe before the meeting