Perspectives on adherence to ethics standards and behaviour in software development

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ABSTRACT

Considering the powerful position assumed in creating software that changes human lives and society; it is compelling that in addition to technical standards, ethical standards, especially those captured in codes of ethics and practice be adhered to by software engineers. Despite efforts by professional bodies on ethical standards awareness, it is alleged that software engineers are not able to uphold ethical standards in software development projects. This research study probed lecturers concerned with the teaching of software development courses to determine their perceived levels of ethical standards and behavior. The findings show that the importance of ethical standards is recognized. The respondents reported high levels of ethical standards of their own work, colleagues' work and their students' work. Although in general the respondents reported high ethical standards, elements of lesser perceived ethical standards on students indicate the need for improvements. The findings of the study are important to educators and industry to recognize the significance of levels of ethics standards and the role educators have in terms of inculcating such ethical standards early in the making of future software engineers.

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1. INTRODUCTION

The software engineering practice emphasizes the application of technical standards in software development [1]. However, it also recognizes the need to synergize them with professional ethical standards [2], which, amongst others will ensure that engineered software products reflect public good [3]–[5]. This is more so because software development projects involve people from different backgrounds [6]. Several advances including professionalization of software engineering and activities of academic enterprise have made significant strides towards improved ethical standards of practice including the conception of software engineering ethics. Software engineering ethics studies interactions between technology and ethical principles [7], which occur throughout the software process. Supreme to this form of professional ethics is to ensure that the development of software technology reflects protection to human values through standards. Consequently, adhering to these standards assimilates the success of software engineering to echelons enjoyed by other engineering sectors.

In recent years, it has become normal and unsurprising that we depressingly learn about perpetual chilling calamities resulting from non-adherence to ethical standards or even just standards in the software industry. For example, poor system design and lack of integration of government systems which led to simple

mistakes such as wrong financial calculations and undetected invalid identity numbers were fingered by the auditor general as some of the major causes of millions of rands financial losses suffered by the South African government during its Covid-19 social distress relief efforts [8], [9]. Once again, this was an indication that software engineers fell short of all forms of standards. One protectionism narrative commonly advanced by ethically complicit software engineers is that "I am just an engineer" [10]. This indicates that consideration of ethical standards is a burden on their already excessive technical responsibilities, therefore implying that they cannot be blamed for ethical lapses. Considering the powerful position a software engineer assumes to create software artefacts that significantly change human lives for good and the bad, it is compelling to expect high levels of ethical standards in software engineering. In progressive reciprocity, professional societies publish professional codes of ethics to provide ethical principles and standards to guide software engineers, and also to bring public confidence in the profession [3], [4], [11]. However, to measure the application of software engineering ethics in software development environments, the antecedent is to determine the existence or non-existence of an ethical climate by analyzing variables or constructs that lead to ethical behavior [12], [13]. Extant literature supplied measurable constructs that characterize or lead to ethical behavior and these include awareness of codes of ethics, understanding, communication, enforcement and intention to behave ethically [12]–[16].

Despite these efforts, Shahriza and Karim [17] submit that software practitioners are not able to uphold ethical standards in software development projects. This could explain why Cheng *et al.* [18] observe that despite the understanding of ethics, an analysis of professionals is important to determine the extent of their ethical standards. Furthermore, earlier researcher Oz [19] in his analysis of various codes of ethics, expresses the need for research on ethical standards in computing, followed by Campbell [20]'s proposition that ethical standards should be placed and tested in practice. Based on these assertions, we posit that the measurement of perceived ethical standards in software development environments warrant attention. The fact that codes of ethics awareness, understanding and perceived usefulness lead to code-influenced behavior standards as evidenced by [13], [14], [21], it is therefore conceivable to submit that standards should be used to measure the levels of ethical awareness in organizations. In support of this view, Wotruba *et al.* [21] acknowledge that research studies on ethics codes awareness have limited such determination to the existence of such codes, discounting the extent of familiarity with contents of the codes, hence in this research we proceed to measure the perceived levels of ethical standards. The question that emerges to be answered by this study is: *What is the perceived level of ethical standards and associated ethical behavior that is a result of awareness of software engineering codes of ethics in software development environments?* The findings of the study will help to provide an understanding of the role of software engineering ethical standards in organizations as a measure of ethical awareness, a construct of ethical climate. Furthermore, the findings can assist the software engineering profession, including educators, to realize the importance of inculcating ethical standards as part of obligations indicated in the professional codes of ethics and practice to ensure that software development meets not only technical standards but also ethical standards to protect the society.

The rest of the paper is organized as shown in: the next section, section 2, reviews literature to provide background to the study. Methodology is presented in section 3, results and discussion of the results are presented in sections 4 and 5 respectively. Section 6 summarizes the study with a conclusion, while Section 7 provides limitations and future studies.

2. LITERATURE REVIEW
2.1. Ethical awareness in software engineering

Research on ethical practices in organizations proved that ethics is one of the determining factors for organizational effectiveness [15], [22]–[24] and means for long-term sustainable business benefits [25]. It is on the basis of the intended sustainable business benefits that Sims [26] considers that the institutionalization of ethics should form the lifeblood of the organization through communication for awareness, enforcement using rewards and sanctions, financial and policy commitment and assimilation into the organizational culture amongst others. It is the institutionalization of codes of ethics [26], [27], in tandem with attitudes and behaviors that contribute significantly to organization's ethical climate [21], which leads to ethical behavior by employees [13], [14], [21]. This institutionalization, apart from company internal codes, also allows for reliance on professional codes bodes well with the practice in software engineering, which primarily uses professional codes of ethics and standards. In support of the communication of codes for awareness aspect, Pierce and Henry [28] submit that such communication of the codes should also include the philosophy embedded in the codes, because that leads to effectiveness of the codes. One of the measures for determining the propensity of employees to behave ethically in discharging their work responsibilities is the level of awareness on codes of ethics [13], [21]. Ethical awareness determines the extent of knowledge of codes of ethics and ability to consult them in case of a need for ethical reference. It also includes the sensitivity or

ability to recognize an ethical dilemma [29], [30]. Huff and Furchert [31] believe that the worth of awareness should go beyond knowledge of principles and obligations, but also include skills to succor with their practical application; with such skills embedded in the software process [32]. In support, Marebane and Hans [33] and Kavathatzopoulos [34], [35] suggest for an expansion which apart from knowledge and skills elements, adds disposition element to complete ethical competence (ethics knowledge+skills+dispositions), an armory fit to navigate ethical challenges. In demonstrating awareness, over adherence, software engineers are also obliged to reject decisions that violate their professional standards [36] and position themselves as social justice activists for socially responsible software development. For example, news reports indicate that Google and Microsoft employees protested to the bid of building an Artificial Intelligence cloud based solution for the United States Defence arguing for ethics over profits [37]. The protest ultimately led to Google cancelling the bid [38]. In the same way as argued by Friedman [39] on business ethics oxymoron, the same pre-disposition displayed by employees of the aforesaid tech companies can help to dissipate the germination of software engineering ethics oxymoron. In reflection, software engineers may view the core of their work as meeting the technical standards of a software solution, and consider observation of social matters of such ethical standards as inhibitive to meeting technical standards or unimportant to their work. However, the abovementioned incident by employees of Google and Microsoft shows that technical and ethical standards should complement one another.

2.2. Application of ethics standards in software engineering

The subject of ethics in computing has registered positive interest [40] specifically with ethical awareness being a frontrunner for institutionalization of codes of ethics. This befits the profession of software engineering, which uses ethics codes developed by professional societies and software development organizations. Among others, the codes provide clarity about the applicable technical and ethical standards of practice [3], [5], signify a positive ethical climate to employees and impact on ethical behavior [21], communicate shared values to the profession, academia and public, and also a way for public scrutiny and affordance for accountability [23]. To a software engineer, standards should be a test on the quality of work and ability to meet ethical standards in comparison to equally competent professionals in the domain [41]. Therefore, respect for ethical standards serve not only to elevate the profession and companies at organizational level, but also at individual level to improve the status and successful career progression of a software engineer. Furthermore, given the privilege a software engineer has in designing and writing algorithms that result in software artefacts that shape the society, the software engineering space positions the software engineer to apply ethical standards to advance a better society and future.

2.3. The influence of codes of ethics on ethical standards and behavior

Several studies that determine the influence of ethics code awareness of practitioners as a predictor of ethical behavior in various domains have yielded varying results [42], namely, positive [13], [14], [28], [43]-[45] negative [46]-[48] and in some cases mixed outcomes. Therefore, to conclusively express with confidence the effectiveness or ineffectiveness of codes of ethics should be done with caution. The success or failure could be attributable to mediating factors [45], [49]. For example, some researchers such as Valentine and Barnett [45] indicate that the mediating factor between ethics code awareness and organizational commitment relationship is the perception on ethical values while Pierce and Henry [28] argue that professional codes, ethics study and law influence personal codes. To extend the argument on mediating factors, we posit this could also apply in reverse to an extent to which people with better personal codes view can likely respond positively to professional codes. Furthermore, Sims and Koen [50] indicate that if personal and co-worker codes are to be added to organizational codes, more ethical behavior can be expected from an employee. In the following paragraphs, few examples illustrate the influence of codes of ethics awareness on ethical behavior.

On the positive note, a study conducted in 2010 by McKinney *et al.* [43] in the USA shows that awareness of codes of ethics reduces unacceptability of unethical behavior on other stakeholders in business, except customers. Similarly, a 2017 research study by Kumasey *et al.* [44] in Ghana shows that awareness significantly influences employee's commitment to the organization in the affective, normative and continuance dimensions. Munro and Cohen [14] and Bricknell and Cohen [13] surveyed information technology (IT) professionals in South Africa and their studies congruently showed that awareness, institutionalization and enforcement of codes is effective in influencing ethical behavior. Valentine and Barnett [44] obtained the similar results, specifically they found that *"ethics code awareness was associated with perceptions of more ethical organizational values and greater levels of organizational commitment",* a congruence to Sims's [26] application of institutionalization. Though these studies yielded positive results, they do not measure the levels of ethical standards application in relation to the codes.

On the negative, a study by Laczniak and Inderrieden [47] established that ethics code alone does not influence behavior. Support structures such as enforcement and identification of unwanted unethical behaviors are needed too to influence behavior, a view which is supported by Harrington [49]. Similar

findings were also made by Mcnamara, Smith and Murphy-Hill [46] who determined that exposure to a code has no effect on ethical behavior or intention to behave ethically. A study by Upadhyay and Singh [48] proved that performance pressures override ethics in companies, despite existence of ethics code. Software development projects are naturally pressure-prone owing to time boundedness and technological changes. These characteristics inherently exert pressure on software engineers, thereby opening up software development projects for candidacy to override the consideration of ethics standards. Another study by McKinney *et al.* [43] further showed, with mixed results, that ethics codes are not successful in discouraging unethical behavior, but only succeed to promote ethical behavior with respect to customers.

Ethical standards of information systems (IS) practitioners were investigated by Shenas [51], who found that academics in IS rated high on viewing issues as unethical, therefore exhibiting high ethical standards. In consideration of the unprecedented explosion of software technology, Reamer [52] implores practitioners to determine the necessary adjustments on the ethical standards to keep up with changes. As alluded before, this paper intends to determine the level of perceived ethical standards as part of awareness on software engineering ethics code in software development environment concerned with educating future software engineers.

3.　RESEARCH METHODOLOGY

To answer the research question of this study, an online survey on academics involved in the teaching of software development was utilized to collect data. The collected data formed part of a research project aimed at establishing software engineering ethics climate in South African software development environments, which includes academic environments. One hundred and three (103) teaching staff from two computing departments in a university of technology were invited through emails, which contained the survey link to voluntarily participate in the study over a period of 6 months. A response rate of 43% was achieved, meaning that 44 of the 103 invited participants anonymously responded. In answering the research question of this study, which is, *What is the perceived level of ethical standards and associated ethical behavior that is a result of awareness of software engineering codes of ethics in software development environments?,* the survey results with measures for perceived ethical standards, are presented in the next section.

4.　RESULTS AND DISCUSSION

This section presents the results of the survey on the perceived level of ethical standards and behavior from the participants. The measurements used to gauge the perceived level of ethical standards and behavior were as presented in Table 1 and the subsections below. The first section in 4.1 of the results containts demographic characteristics of the participants while section 4.2 presents the measures used to gauge the reported ethical standards and behaviour of the respondents.

4.1.　Demographic characteristics of the participants

The majority (77%) of the respondents were male, while the age range of the majority (68.2%) of the participants was between 30 and 39 years. In terms of qualifications, 75% of the respondents had a postgraduate qualification, whereas 23% had diploma, degree or doctoral qualification, while 2% preferred not to specify. In terms of work experience, the results show that 29.5% of the respondents had more than 10 years, 13,6% ranged between 6 and 10 years of experience, 25% had between 3 and 5 years of experience, while 15.9% and 2.27% of them had between 1 and 2 as well as less than 1 year of work experience. The participants who had no lecturing experience were 13.6%.

The employment ranks of the participants were as follows: the majority (52.3%) of the participants were holding lecturer positions, junior lecturer positions (36.4%), senior lecturer (9.1%) and the remaining 2.2% elected not to specify their positions. It was not possible to determine if there were respondents with professorship positions since some participants did not close their positions. Only 11.4% of participants had membership with professional bodies, the rest were without an affiliation.

4.2.　Perceived level of ethical standards and behavior

The results show that majority of the respondents perceive ethical standards and behavior in software engineering as important hence their own work ethic standard is reported to be high and also that of colleagues. As indicated in Table 1, 70.5% of the participants considered their work to be very ethical, while 27.3% of the respondents regarded their work to be somewhat ethical. In terms of rating colleagues' work ethical standards, 47.7% of the respondents considered their colleagues' work to be very ethical; at the same time, 45.5% of the respondents regarded their colleagues' work to be somewhat ethical. However, one respondent indicated that his/her own work is generally unethical, while another (maybe the same or a different participant) respondent also stated that the work from colleagues was normally unethical. Even

though these responses came from one or two persons, it should be concerning given that they were from an educator (s) tasked with a responsibility of educating future SEs on ethical standards and behavior.

Table 1. Measures of perceived ethical standards and behavior of the respondents

Measurements	Responses	Frequency	Percentage	Cumulative
The rating of one's work ethical standards in academic environment	Generally unethical	1	2.27	2.27
	Somewhat ethical	12	27.27	29.55
	Very ethical	31	70.45	100.00
	Total	44	100.00	
The rating of colleagues' work ethical standards in academic environment	Generally unethical	1	2.27	2.27
	Somewhat unethical	2	4.55	6.82
	Somewhat ethical	20	45.45	52.27
	Very ethical	21	47.73	100.00
	Total	44	100.00	
The rating of students' work ethical standards in academic environment	Generally unethical	4	9.09	9.09
	Somewhat unethical	12	27.27	36.36
	Somewhat ethical	18	40.91	77.27
	Very ethical	10	22.73	100.00
	Total	44	100	
Enablement or encouragement of students to do something unethical	No, not to my knowledge	42	95.45	95.45
	Yes	2	4.55	100
	Total	44	100.00	
One's reaction on discovering unethical related issues at work	It depends on what the problem is	15	34.09	34.09
	Nothing, because it is not my responsibility	1	2.27	36.36
	Report it to my line manager or colleague	28	63.64	100
	Total	44	100.00	
Legality of software used at work	All my work software is properly licensed or free to use	33	75	75
	I do not know if the software that I use at work is licensed or free to use	2	4.55	79.55
	Most of my work software is either properly licensed or is free to use	9	20.45	100
	Total	44	100.00	

On the other hand, the respondents perceived their students' work to be ethical, although 40.91% of them were not fully convinced about the ethicality of their students' work. At the same time 9.09% perceived students' work as generally unethical. In other words close to 30% of the participants considered their students' work to be unethical and this is not surprising considering findings of previous studies on this matter. Notwithstanding the fact that these results are from educators and not from students, this finding is generally in line with the findings of other previous studies, including a recent study by Taajamaa *et al.* [53], which indicates that younger engineers do not consider ethics issues as important at work as compared to the matured older engineers.

Though self-reporting could have led to biasness in terms of the respondents considering themselves as having higher ethical standards compared to students, this finding is intriguing as the teaching staff and students operate within the same work environment in which software development is being taught and learnt. Firstly, it could be expected that the same organizational environment, which rightfully should imbue the same ethical standards influence, students' ethical standards are perceived to be lower than that of teaching staff. Secondly, although the number of those who claimed their students' work to be unethical is marginal (9.09%), such finding is hard to ignore because the very students are future software engineers in the making. Therefore there is a risk of graduating engineers that have low ethical standards. The lesser perceived ethical standards of students could be a sign that there are deficiencies in the system with regards to empowering students with ethics, such as insufficient coverage of ethics topics as determined in a study by Marebane and Hans [33]. An alternative explanation could be that, such lesser ethical standards are the results of an influence outside the current system or that the students are still in their formative stages of ethical development. However, despite the lack of influence from the current system, it is believed that personal ethical codes also contribute to one's determination to act ethically or unethically as shown in a study by [28]. Following, on the preceding finding on own ethical standards, about 96% of the respondents indicated that they never encouraged or enabled students to behave in an unethical manner. This demonstrates that many would like to see their students upholding ethical standards. Moreover, these results are encouraging especially that the lecturers are positioned to lead as living and practical ethical examples to the students. In terms of a reaction to unethical incidents, the results show that many lecturers would not turn a blind eye on unethical conduct if it were detected at their work place. The findings of the study presented in

this paragraph indicate that the ethical radar of the respondents is enabled, which is a confirmation of the reported high ethical standards.

It is pleasing that the majority of the respondents (63,64%) would report a colleague's unethical conduct. However, it should be concerning that more than a third of the respondents would base their decision of reporting or not reporting an incident of unethical behavior on the nature of the problem itself whilst one respondent does not consider reporting unethical behavior as her/his responsibility. This shows that there might be occurrences of unethical behavior in their workplace that could go unreported. The fact that an incident of unethical behavior has been detected should be a reason good enough to warrant them to act (report it). Lack of reporting may signal lower ethical standards of the respondents in terms of assisting to deal with unethical behavior.

In terms of legality of software used, the results suggest that the majority of respondents are highly ethical in terms of software acquisition. This finding comes as no surprise because Akman and Mishra [54] posit that government sector is more aware about software licenses although they are lenient towards the use of illegal software. The respondents of this research study work in a public university, which is aligned to government. Only two respondents (4.5%) did not know if the software was properly acquired, which does not necessarily mean the software is illegal [55].

5. CONCLUSION

In this study, we investigated the perceived level of software engineering ethical standards by computing lecturers. The results show high levels of self-perceived ethical standards by the respondents and on their colleagues, and lesser but above average ethical standards by students, which is a sign for ethical awareness in a workplace. Therefore, the study has shown the level of ethical standards by computing lecturers in an environment for teaching software development as a follow-up to another study of this project which determined lecturers' software engineering ethics codes awareness. However, the lesser perceptions of ethical standards on students by their lecturers as compared to themselves and their colleagues remain a challenge and a concern. In contrast, this brings a question about the difference in influence by the ethical climate of the environment in which the lecturers and students' function, which ideally should impact similarly to them all. Therefore, we recommend improved initiatives on the institutionalization of ethics code aimed at teaching students' software engineering ethics standards. The results also show significant perceived ethical standards in terms of responses to unethical incidents, an indication of acceptable standards of enabled ethical radar or sensitivity. However, the indications of uncertainty on what action to take when faced with incidents of unethical behavior indicates the need to improve ethical awareness in order to achieve better ethical standards in the teaching environment. Furthermore, the results show the majority of respondents use licensed software, which is another indication of upholding ethical standards and functioning ethical climate. The results and findings presented in this study are based on self-reporting data collected from computing educators of one institution. The results of a case-study are not necessarily generalizable, while self-reporting has an element of bias. However, these limitations provide an opportunity for future studies to investigate the issues raised in this study on a broader scale. Furthermore, a research study could be conducted to determine students' ethical standards by collecting data directly from them and then compare such results with this study's results.

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