THE IMPORTANCE OF SOFTWARE ENGINEERING CODE OF ETHICS IN A UNIVERSITY OF TECHNOLOGY TEACHING ENVIRONMENT

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ABSTRACT

Positive consideration of software engineering codes of ethics by computing educators promotes inclusion in the teaching of software development courses. For computing educators, this is significant because they contribute immensely to the development of software engineering graduates, not only in terms of teaching technical skills but also in ethical development. This study aims to investigate the perceived importance of codes of ethics by lecturers who teach software development courses at a University of Technology in South Africa. The data was collected using an online survey from 103 educators from two computing departments in a South African UoT; 44 responses were received. Data was analyzed using descriptive statistics to evaluate the responses; the Pearson Chi-square test was applied to assess the level of association between variables of interest for more conclusive results in addressing the objective of the study. The results of this study indicated that the majority of participants were males; female participants amounted only to 18.2 per cent. Results also reported that most participants agreed with all the statements tested to determine the perceived importance of Software Engineering Codes of Ethics to educators. In addition, an association was presented between the importance of a software engineering code of ethics to an educator and three other variables (the need to teach students about ethical behaviour, an obligation for software engineers to consider the ethical implications of their systems and sex of the respondents) respectively. This study recommended that institutions of higher learning consider finding permanent ways of inculcating a culture of ethical

conduct into its staff members, encouraging educators to take up professional memberships with professional bodies. These measures will ensure that software development educators are trained to maintain high standards within their profession, embracing the use and adherence to a code of ethics in the teaching of software development courses.

Keywords: perceived importance, software engineering ethics, ethics education, ethics awareness, ethical behaviour

INTRODUCTION

There is no argument over the need for institutions of higher learning to educate software engineers (SEs) on ethical and moral behaviour in the process of developing software solutions. Because the solutions of the computing field are used by other disciplines and sectors, the interdisciplinary nature of computing education cannot be overemphasized (Järvi, Taajamaa, and Hyrynsalmi 2015, 13). In recognition of the need to enable practitioners to develop ethical software, knowledge of the relevant ethical principles is required. Therefore, to teach ethics to software engineering students because of the identified knowledge gap in the area (Lethbridge 2000, 50), the inclusion of the software engineering code of ethics (SWECoE) as content for software development courses is encouraged (Gotterbarn, Miller, and Rogerson 1997: 84; Wilford and Wakunuma 2014, 284). Whilst ethics are a part of both moral development (Kohlberg and Hersh 1977, 53) and professional development (Bot, Coleman, Eaton 2001, 16), the codes provide devices for articulating values and organisational processes for maintaining the way in which internal and external stakeholders view organisations (Valentine and Johnson 2005, 45). Therefore, for software engineers (SEs), ethics education will greatly assist in aligning them with the ethical agenda of their organisations and the need for good citizenry. Despite this necessity, the computing curricula of many institutions of higher learning do not make it mandatory for undergraduate students to take ethics as a subject (Taajamaa et al. 2018, 90). Such curricula encourage students to focus solely on technically related skills (Froyd, Wankat, and Smith 2012, 1354; Wilford and Wakunuma 2014, 278), neglecting transversal skills, such as professional ethics. Furthermore, a study by Marebane and Hans (2021, 589) found that universities of technologies (UoTs) in South Africa were not covering SWECoE sufficiently in their curricula. Taken at face value, this finding could be considered to imply that a code of ethics is not regarded sufficiently important by South African UoTs.

Regardless of the above-mentioned state of affairs, it is incumbent on the educators at institutions of higher learning to prepare students to behave ethically in developing their software artefacts (Huff and Furchert 2014, 27). This is also supported by an assertion in the ACM/IEEE-CS code of ethics (IEEE-CS 1999), which states that educators are duty-bound to promote the profession in the classroom. This is imperative, given various reported incidents

of unethical behaviour and misuse of software products, as alluded to by numerous researchers, including Rashid, Weckert, and Lucas (2009, 36) and Wardle and Singerman (2021, 1).

Compounding to the lack of sufficient inclusion of SWECoE in South African UoTs' computing curricula, as indicated above, a study by Hans, Marebane, and Coosner (2021, 590) A established that the majority of the educators at one of the South African UoTs were not aware of the software engineering code of ethics. However, the same study did not determine the way in which those educators who were aware of code of ethics perceived the importance of teaching the ethics codes to future SE graduates. Perceiving codes of ethics is important and assists organisations, managers, and employees alike in advancing into an organisational ethical context and standards and feel compelled to derive positive influence from them (Valentine and Johnson 2005, 49). Furthermore, the expectation that professionals should perceive ethics as important in order to demonstrate ethical behaviors is based on moral philosophies (Singhapakdi 1999, 90). This is equally the case with the expectations of the software engineering profession. Similarly, teachers who perceive codes of ethics as important are likely to behave ethically. Subsequently, they will be inclined to expect the same ethical behaviour from their students and use the codes of ethics to teach students to develop ethical behaviours. In the quest to understand how important are codes of ethics, several studies, such as those by Cronan, Leonard and Kreie (2005) and Taajamaa et al. (2018), have been conducted to assess the perceived importance of ethics or a code of ethics by students (future software engineers) and practising software engineers. Given that educators have the responsibility of teaching future engineers about SWECoE and its importance, it is imperative to understand the value they attribute to a software engineering code of ethics. Furthermore, a study by Leonard and Cronan (2005, 1167) showed that ethical attitude influencers change over time, so a constant assessment of the ethical climate is crucial. According to Taajamaa et al. (2018, 91), a focus on technical competencies by educators of engineering-like subjects tends to allow these educators to pay little attention to the importance of ethical issues. Therefore, this study aims to determine the extent to which computing educators in a South African University of Technology (UoT) consider a software engineering code of ethics as important in their work environment. In other words, the objective of this study is the following:

- To determine the perceived importance of a software engineering code of ethics by educators involved in the teaching of software development courses.

Educators must be committed to the code of ethics and willing to practise and apply it (Pierce and Henry 1996, 427). Educators can only do this if they consider such codes important.

The significance of this study is that its findings will help us understand the value that educators assign to the code of ethics applicable to software development. This will, in turn, indicate the propensity of the educators to demonstrate ethically exemplary behaviour to students. In support of this view, Bricknell and Cohen (2005, 63) show that regard for the importance (usefulness) of a code of ethics is likely to lead to someone behaving ethically), and also include it their teaching of software engineering courses.

In the next section, we address the theoretical foundations that underpin this study. We also review studies conducted on the topic of this study to provide a background of what literature contains about this subject.

LITERATURE REVIEW

Many organisations, including those in the software-engineering profession, have realized the need to promote ethical behaviour (Oz 2001, 137) by codifying their expected standards of conduct (McKinney, Emerson, and Neubert 2010, 506). This is also conducted as part of professionalizing the software engineering practice to be recognized in the same way as other engineering fields. Codifying also prevents destructive consequences resulting from unethical behaviour (McKinney et al. 2010, 506). This effort has become even more relevant as occupational groups are faced with the increasing challenge of a crisis in public confidence in members of professions (Banks 2003, 133) and the products and services they offer to the public. The codification of the software engineering profession has culminated in the publication of software engineering codes of ethics which guide the profession in its practice and also in its educational endeavours. Popular exemplars of ethical codes include those published by ACM and IEEE.

A code of ethics or an ethical code is defined by Schwartz (2001, 248) as “a written, distinct, and formal document which consists of moral standards used to guide employees or corporate behavior”. Code of ethics documents contain statements written by professional bodies to (1) guide member practitioners, (2) protect society, and (3) guard the reputation of the profession (Banks 2003, 133). In terms of the first point, the code inspires, educates, influences ethical decision-making, and provides an ethical frame of reference to practitioners in case of an ethical dilemma (Weckert and Richard 2013, 261; Bricknell and Cohen 2005, 55). On the second point, the codes instill confidence in the public about the capabilities and ethical values of the practitioners and can assist in holding practitioners accountable. Therefore, the code motivates practitioners to put public interest first and ensure that known ethical risks are dealt with to protect public interest. On the third point, business leaders adopt and publicize codes of ethics to communicate to the public its commitment to norms of appropriate behaviour, and

affirmation of its adherence to high ethical standards (McKinney et al. 2010, 506). Therefore, members of a profession are expected to conduct themselves in line with the prescribed code of ethics (Weckert and Richard 2013, 261), especially because one of the critical pillars that define a profession is a code of ethics. However, for codes of ethics to be effective in positively influencing the ethical behaviour of practitioners, proper communication and enforcement mechanisms must form part of the business ethics strategy (Munro and Cohen 2004, 923; Bricknell and Cohen 2005, 62; Jose and Thibodeaux 1999, 140; Sims 1991, 503). It is through institutionalization that professionals can be assisted to perceive codes of ethics as important to the software engineering practice.

As cited in the preceding section, having codes of ethics has several advantages. Furthermore, it is argued that for professionals to find purpose in codes of ethics, they need to perceive them as important to their work and organisational effectiveness (Singhapakdi 1999, 90). In this case, the perceived importance of a code of ethics relates to the usefulness that software engineers ascribe to codes of ethics in their professional work. According to ACM/IEEE's code of ethics (IEEE-CS 1999), software engineers are not only expected to commit to making software development a respected profession and beneficial to society, they should also live by the adopted software engineering code of ethics. This statement signifies the importance of codes of ethics for keeping SEs in check in their behaviour and conduct. Ethics and professionalism were rated number eight out of the twenty-five most important topics which software engineers should have knowledge of (Lethbridge 2000, 47). However, Lethbridge (2000, 47) also indicates that ethics and professionalism are some of the topics in which SEs have knowledge gaps.

The role of a software engineering code of ethics in conscientizing SEs on their ethical obligation to the public is unquestionable. Such a code of ethics indicates the necessary principles to be upheld in their conduct (Gotterbarn et al. 1997, 84; Gotterbarn 2001, 229). The usefulness or perceived importance has emerged as one significant characterization of employees' awareness of professional ethics or ethical practices (Wotruba, Chonko, and Loe 2001, 62; Cronan et al. 2005, 236) − ethical awareness with perceived importance that leads to successful enterprise (Singhapakdi et al. 2008, 900). Such awareness goes beyond having knowledge that codes exist somewhere in the organisation or in the profession. Rather, the awareness ought also to relate to internalising these codes. Thus, practitioners are enabled to apply them in practice (Huff and Furchert 2014, 26) preventatively, correctively, politically, and otherwise, as ethical issues arise. Literature provides several factors such as age, sex, gender, education level, organisational and country culture, inter alia, that positively influence the perceived importance of ethics. In addition, Singhapakdi et al. (2008, 891) postulate that

perceived importance is confirmed by the likelihood of an employee to perceive an ethical problem in a work situation. These employees would differ from those who perceive ethics as unimportant.

As alluded to above, several socialization factors have been considered as playing a pivotal role in influencing the perceived importance of codes of ethics. Hence several researchers have studied such factors. For example, Cronan et al. (2005) assessed the relationship between perceived importance, attitude, and behavioural intention of students. This was to determine their perceptions of the importance of ethics by considering the impact of age and sex differences. It was found that individuals (females and males) generally judge behaviour as unethical only when the identified unethical behaviour affects an issue that is considered important to them. Such individuals are inclined to correct unethical behaviour by acting ethically. In terms of sex differences in the perceived importance of ethical issues, it was found that females perceive ethics as much more important than males, whilst age yielded mixed results. Similar findings were attained by Singhapakdi et al. (2008) in terms of perceived importance, although sex was not used as a factor. It was determined that ethical values wield a positive influence on managers. In other words, managers who perceive ethics as important are more likely to identify an ethical challenge in practice, thereafter intending to act ethically, compared with those who do not perceive ethics as important. Although the study (by Singhapakdi et al. 2008) was conducted in Thailand, it corroborates a study conducted in the US by Singhapakdi (1999). Both studies found that individuals who perceive ethics as important are inclined to act ethically. In contrast, a study by Taajamaa et al. (2018) found that engineers do not perceive ethical issues as important to their work. However, it emerged that mature age signalled a positive consideration for ethics. This finding is in line with a study by Wilford and Wakunuma (2014, 280), which may suggest that education has been unsuccessful in inculcating awareness during the engineers' formative years. However, other socialization factors such as work experience and increased responsibilities in adult life were found to be able to influence mature engineers.

For ethics or codes to be perceived as important, impactful awareness needs to be established through institutionalization, as posited by Sims (1991, 503), Munro and Cohen (2004, 923) and Bricknell and Cohen (2005, 62). Some authors suggest that such should include integrating awareness into the organisational strategies and operations (Obalola and Adelopo 2012, 429), including such in training and in all communication opportunities (Valentine and Johnson 2005, 46; Singhapakdi 1999, 97). The training should include aspects which address specific ethical challenges, stretching as far as covering grey areas rather than merely regurgitating principles. Wilford and Wakunuma (2014, 280) submit that for awareness through

education to make a dent; computing curricula should shift from the conventional. In essence, Taajamaa et al. (2018, 91) agree that such a move should enable engineers to "create true freedom of thought that generates critical and creative thinking" and create an "understanding of how new technologies take environmental, economic and social boundaries into account". In considering that environmental, economic, and social boundaries are political constructs, Green (2020, 40) suggests that the inclusion of political responsibility be added to the repertoire of ethics studied by engineers.

The need for transformation in ethics education is posited by Taajamaa et al. (2018, 91) and Green (2020, 26), who submit that educational environments and educators should be evaluated for the perceived importance of ethics in their field. Hence, we posit that, despite engineers being corporate-employed or self-employed to create software products, they are, by association, agents of the company and profession in which they ply their trade; and of the broader society, specifically, moral agents. In the same vein, computing educators should be seen as moral agents of the software engineering profession and their university faculties, and candidates to be evaluated for their perceived importance of software engineering codes of ethics.

Code of ethics is important device in influencing ethical behaviour and guiding ethical decision-making in organisations. They have become even more important to software engineering educators as they are positioned to develop the ethical competence of SEs in training. Therefore, the evaluation of the importance these educators attribute to software engineering codes of ethics is valuable. Hence this study seeks to determine the extent to which computing educators in a South African UoT consider a software engineering code of ethics as important in their work environment.

RESEARCH METHODOLOGY

This study forms part of a larger research project aimed at gauging the ethical climate in software development environments in South Africa, teaching environments included. Ethics approval with reference number REC2019/10/004 from the Tshwane University of Technology Research Ethics Committee was obtained to carry out the study. To collect data, an online survey questionnaire was used to allow data gathering anonymously and voluntarily. In order to ensure the correctness of the data-collection instrument, some targeted participants were invited to participate in a pilot test. The link to the online questionnaire was shared (through emails) with 103 targeted population of educators from two computing departments of a South African UoT. The 103 educators were the total number of lecturers that were employed in the two computing departments of the mentioned UoT. The usable data collection responses were

44, amounting to an 88 per cent response rate from the actual calculated sample size of 50. The responses of 44 were received from an estimated sample size of 50 derived from a population total of 103 with a 95 per cent confidence interval and a 10 per cent margin of error.

Besides the profile-related questions, the respondents were asked five questions to establish their perceived importance of software engineering code of ethics. As a way of ensuring that relevant participants took part in the survey, only lecturers with a computing lecturing job description were permitted to complete the rest of the questionnaire. All the five questions related to the perceived importance of software engineering codes of ethics required the participants to respond by choosing answers from a four-point Likert scale range.

This is a quantitative study, and thus descriptive statistics were used for data analysis to address the research question stated in the introduction section. Descriptive statistics (frequency and percentage), together with Chi-square, were used to summarise data and assess associations between variables considered in the study, respectively. The study used Chi-square to assess the association between how participants perceived software code of ethics by; a) participants' profile information; b) the ability of SEs either to do good or cause harm with their products; c) SEs' obligation to consider ethical implications of their systems; d) the need for professional ethics for the software industry; and e) the importance of teaching students ethical behaviour. The results of the study are presented in the next section.

RESEARCH RESULTS

The discussion in this section presents the research results of this study, starting with the profile of the participants, followed by the results of the survey on the perceived level of the importance of a code of ethics, as indicated by the participants. The following statements were used as measurements to gauge the perceived level of importance of a SWECoE by the participants:

(a) The importance of a software engineering code of ethics to lecturers
(b) The ability of SEs either to do good or cause harm with their products
(c) SEs' obligation to consider the ethical implications of their systems
(d) The need for professional ethics in the software industry
(e) The importance of teaching students ethical behavior.

Profile of participants

Table 1 provides demographical information on the participants. As indicated under the Research Methodology section, of the 103 educators contacted for participation in the study, only 44 responded with usable answers. The majority of participants (77,3%) were males compared with 18,2 per cent female counterparts. Some 4,5 per cent of participants opted not

to disclose their sex. These results show that the sex split was skewed towards males. About 68 per cent of the participants were between 30 and 39 years of age 18,2 per cent were between 40 and 49 years old, while the remaining 13,6 per cent were between 50 and 59 years of age.

Some 77,3 per cent of respondents possessed post-graduate qualifications (including doctoral degrees), whereas 20,5 per cent had either degree or diploma qualifications. The remaining 2,3 per cent of the participants preferred not to mention their qualifications. The results show that 29,5 per cent of the participants had 10 years or more of working experience in the software development industry. Those who had between 3 and 5 years of software development experience amounted to 25 per cent of participants. The educators who had between 1 and 2 years of software development experience, as well as those who had less than 1 year of work experience, numbered 15,9 per cent and 2,3 per cent, respectively. The number of participants who had between 6 and 10 years of software development industry work experience was 13,6 per cent. At the same time, the remaining 13,6 per cent did not have any experience in software development.

Just over 52 per cent and 36 per cent of the respondents held lecturer and junior lecturer positions, respectively. For this study, 9,1 per cent of the participants held senior lecturer positions, while the remaining 2,3 per cent preferred not to disclose their positions. Because some participants decided not to disclose their positions, it is not possible to determine whether there were individuals who held professorship positions in the two departments. However, if there were, those would be very few. The results show that only a few (11,4%) educators belonged to professional bodies.

Table 1: Profile Details of the Participants

Profile variables	Description	Frequency	Percentage
Sex	Female	8	18,2
	Male	34	77,3
	Prefer not to say	2	4,5
	Total	**44**	**100,0**
Age group	18–29	0	0,0
	30–39	30	68,2
	40–49	8	18,2
	50–59	6	13,6
	60 and above	0	0,0
	Total	**44**	**100,0**
Highest level of formal education	Degree	8	18,2
	Diploma	1	2,3
	Doctoral	1	2,3
	Post-graduate qualification	33	75,0
	Prefer not to say	1	2,3
	Total	**44**	**100,0**

Profile variables	Description	Frequency	Percentage
Experience in software development industry	1–2 years	7	15,9
	3–5 years	11	25,0
	6–10 years	6	13,6
	Less than 1 year	1	2,3
	More than 10 years	13	29,5
	No experience	6	13,6
	Total	**44**	**100,0**
Experience in teaching software development	1–2 years	7	15,9
	3–5 years	12	27,3
	6–10 years	15	34,1
	Less than 1 year	1	2,3
	More than 10 years	8	18,2
	No experience	1	2,3
	Total	**44**	**100,0**
Current job level	Junior lecturer	16	36,4
	Lecturer	23	52,3
	Prefer not to say	1	2,3
	Senior lecturer	4	9,1
	Total	**44**	**100,0**
Membership of SE professional organisation/body	No	39	88,6
	Yes	5	11,4
	Total	**44**	**100,0**

Perceived importance of code of ethics to educators

This section presents the results of the survey on the perceived level of importance of a software engineering code of ethics, as indicated by the participants. Firstly, the discussion presents the results on the question of the perceived importance of the software engineering code of ethics to academics.

Table 2 gives a summary of the statistical analysis results regarding the responses to this question posed to the participants. The overwhelming majority (32; 72,7%) of participants regarded the software engineering code of ethics as very important to the educators, while 8 (18,2%) of them perceived SWECoE as important. On the other hand, 1 (2,3%) and 3 (6,8%) educators considered SWECoE not important and somewhat important, respectively.

Table 2: Perceived Importance of SWECoE by Participants

Statement	Response	Frequency count	Percentage
How important is a software engineering code of ethics to you as a lecturer?	Not important	1	2,3
	Somewhat important	3	6,8
	Important	8	18,2
	Very important	32	72,7
	Total	**44**	**100,0**

This study also wanted to establish the possible relationship or association between the

perceived importance of a software engineering code of ethics variable and (a) the profile variables of the participants, as well as (b) each of the other four measurement variables of the perceived importance of SWECoE. The Pearson Chi-square association test performed on the above-mentioned variables established that there were significant relationships amongst certain variables, as shown in Table 3. The following discussion pertains to the responses of the participant in terms of their profile variables as well as the results of the association test between the perceived importance of a software engineering code of ethics variable and the profile variables of the participants. The discussion will only focus on the cases where the association test returned significant results.

The majority (88,6%) of the participants were not registered with any professional body. Of these, 61,4 per cent and 18,2 per cent considered SWECoE to be either very important or important to educators, respectively, while the other 2,3 per cent and 6,8 per cent of them regarded SWECoE to be unimportant and somewhat important, respectively.

The male participants who perceived SWECoE to be very important and important to educators respectively were 61,4 per cent and 13,6 per cent, respectively. Only 2,3 per cent of the male participants felt that the code was not important. On the other hand, 9,1 per cent of the 18,2 per cent of the female participants considered a code of ethics to be very important, whereas 2,3 per cent of the 18,2 per cent stated that the code of ethics was important. The remaining 6,8 per cent of the female participants said the code was somewhat important. The two participants who preferred not to mention their sex status also indicated that the SWECoE was important and very important to educators, respectively.

According to Table 4, there is a statistically significant association between *the importance of a software engineering code of ethics to a lecturer* and *the sex profile variable of the participants*. The association test between the aforementioned two variables returned a p-value of 0,0139, which is less than $\alpha = 0.05$, thus indicating a statistically significant relationship between the two variables.

Over 68 per cent of the respondents were aged between 30 and 39 years old. Of these, 61,4 per cent indicated that the SWECoE was important (11,4 per cent) and very important (50 per cent). The participants who were between 40 and 49 years of age were 18,2 per cent. Just over 15 per cent of these claimed that the code was either important (4,5 per cent) or very important (11,4 per cent). The remaining 2,3 per cent of this age group considered the SWECoE to be somewhat important.

Almost 18 per cent of the participants had degree qualifications, where 2,3 per cent and 11,4 per cent of these stated that the SWECoE was important and very important, respectively.

Table 3: Pearson Chi-square test results between the perceived importance of a software engineering code of ethics variable and the profile variables of the participants

		Importance of software code of ethics												
		Not important		Somewhat important		Important		Very important		Total				
Variables	**Description**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Chi-square**	**Degrees of freedom**	**p-value**
Professional registration	No	1	2,3	3	6,8	8	18,2	27	61,4	39	88,6	2.115	3	0,5488
	Yes	0	0,0	0	0,0	0	0,0	5	11,4	5	11,4			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			
Sex	Female	0	0,0	3	6,8	1	2,3	4	9,1	8	18,2	15.974	6	0,0139
	Male	1	2,3	0	0,0	6	13,6	27	61,4	34	77,3			
	Prefer not to say	0	0,0	0	0,0	1	2,3	1	2,3	2	4,5			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			
Age group	30–39	1	2,3	2	4,5	5	11,4	22	50,0	30	68,2	1.715	6	0,9440
	40–49	0	0,0	1	2,3	2	4,5	5	11,4	8	18,2			
	50–59	0	0,0	0	0,0	1	2,3	5	11,4	6	13,6			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			
Highest level of education	Degree	0	0,0	2	4,5	1	2,3	5	11,4	8	18,2	10.387	12	0,5820
	Diploma	0	0,0	0	0,0	0	0,0	1	2,3	1	2,3			
	Post-graduate	1	2,3	1	2,3	6	13,6	26	59,1	34	77,3			
	Prefer not to say	0	0,0	0	0,0	1	2,3	0	0,0	1	2,3			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			
Work experience	1–2 years	0	0,0	1	2,3	1	2,3	5	11,4	7	15,9	15.478	15	0,4176
	3–5 years	0	0,0	1	2,3	1	2,3	9	20,5	11	25,0			
	6–10 years	0	0,0	0	0,0	0	0,0	6	13,6	6	13,6			
	< 1 year	0	0,0	0	0,0	0	0,0	1	2,3	1	2,3			
	> 10 years	0	0,0	0	0,0	5	11,4	8	18,2	13	29,5			
	No experience	1	2,3	1	2,3	1	2,3	3	6,8	6	13,6			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			
Current job level	Junior Lecturer	0	0,0	2	4,5	3	6,8	11	25,0	16	36,4	7.813	9	0,5531
	Lecturer	1	2,3	1	2,3	4	9,1	17	38,6	23	52,3			
	Prefer not to say	0	0,0	0	0,0	1	2,3	0	0,0	1	2,3			
	Senior Lecturer	0	0,0	0	0,0	0	0,0	4	9,1	4	9,1			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			

The remaining 4,5 per cent of the degree holders mentioned that the SWECoE was somewhat important to the educators. The diploma holder, as well as the participant who preferred not to disclose his/her qualification perceived the code of ethics as important and very important to the lecturers, respectively. The majority (77,2%) of the respondents possessed post-graduate qualifications. The majority of this group (59,1%) indicated that SWECoE was very important, while 13,6 per cent of the group regarded the code as important. The remaining 4,6 per cent was split equally between those who considered code as somewhat important and not important, respectively.

The participants who had between 1 and 2 years of work experience constituted 15,9 per cent of the respondents. Of these, 2,3 per cent and 11,4 per cent indicated that SWECoE was important and very important, respectively, while 2,3 per cent stated that SWECoE was somewhat important. The group of participants who possessed between 3 and 5 years of work experience made up 25 per cent, whereby 20,5 per cent said that the code was very important to the educators, while the remaining 4,5 per cent was equally split between those who considered the code important and somewhat important respectively. The 13,6 per cent of the respondents with between 6 and 10 years of work experience indicated that SWECoE was very important for educators. The participants who had less than 1 year of work experience constituted 2,3 per cent, all of which stated that the code was very important. The 11,4 per cent of the 29,5 per cent of respondents with more than 10 years of work experience mentioned that the code was important, while the remaining 18,2 per cent said that the code was very important. A 6,9 per cent of the participants who did not have any work experience were equally divided among those who considered SWECoE to be not important (2,3%), somewhat important (2,3%) and important (2,3%). On the other hand, another 6,8 per cent of those who also had no work experience considered the code to be very important.

The respondents who held junior lecturer positions were 36,4 per cent, where 4,5 per cent and 6,8 per cent of this indicated that SWECoE was somewhat important and important, respectively, while the balance (25%) stated that SWECoE was very important. The majority (52,3%) of the participants were in the lecturer positions, where 4,6 per cent of them were equally divided between those who considered the code to be not important and somewhat important. The remaining 9,1 per cent and 38,6 per cent of the 52,3 per cent stated that SWECoE was important and very important, respectively. The only participant who preferred not to disclose the job level indicated the code as important. All (9,1%) of the respondents who held senior lecturer positions stated that the code was very important.

The next discussion presents the answers of the participants to the questions asked that were related to the above-mentioned measurements of the perceived importance of a software

engineering code of ethics. Furthermore, the discussion will also provide information on the association test in the case where a significant relationship was established.

The importance of teaching students ethical behaviour

Table 4 shows that the majority (72,7%) of the participants strongly felt that lecturers should teach their students the importance of ethical behavior. Furthermore, 72,7 per cent of participants also considered SWECoE to be important to lecturers. On the other hand, 22,7 per cent as well as 4,5 per cent of participants agreed somewhat and disagreed somewhat, respectively, regarding lecturers' responsibility to teach students ethical behavior.

The association test results shown in Table 4 indicate that there is indeed strong evidence of a statistically significant association between *the importance of a software engineering code of ethics to a lecturer* and *the responsibility of software engineering educators to teach their students the importance of ethical behaviour*. The association test on the two variables returned a p-value of 0.0091, which is less than $\alpha = 0.05$, thus indicating a statistically significant relationship between the two variables.

The ability of SEs to do good or cause harm with their products

As shown in Table 4, 68,2 per cent of the respondents strongly agreed that SEs have the ability either to do good or to cause harm with the software products. Just over 52 per cent (52,3% to be exact) of the 68,2 per cent also stated that SWECoE was very important, while 9,1 per cent of the 68,2 per cent indicated that the code was important to lecturers. The remaining 4,5 per cent and 2,3 per cent of the 68,2 per cent mentioned that the code was somewhat important and not important, respectively. Just over 27 per cent of the participants agreed somewhat that SEs' products might cause good or harm. Of the 27,3 per cent, 18,2 per cent of the informants regarded SWECoE to be very important, whereas 6,8 per cent and 2,3 per cent of the remaining percentages indicated that SWECoE was either important or somewhat important, respectively. The data also shows that the remaining two participants (4,6%) responded with an equal split between somewhat disagreed and strongly disagreed with the statement presented to them. In return, each of these participants also indicated that SWECoE was very important and important, respectively.

SEs' obligation to consider ethical implications of their systems

The majority of participants (77,3%) strongly agreed that SEs have an obligation to reflect on the ethical impact of their software products. A 63,6 per cent of the 77,3 per cent respondents regarded SWECoE as very important for educators, while another 6,8 per cent of the 77,3 per

Table 4: The Chi-square test results between the perceived importance of SWECoE variable and the other statements used to measure the level of importance of SWECoE.

		Importance of software code of ethics												
		Not important		Somewhat important		Important		Very important		Total				
Variables	**Description**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Chi-square**	**Degrees of freedom**	**p-value**
Teachers of software engineering are responsible to teach their students the importance of ethical behaviour, including quality standards, in software engineering.	Disagree strongly	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	17.059	6	0,0091
	Disagree somewhat	0	0,0	0	0,0	1	2,3	1	2,3	2	4,5			
	Agree somewhat	1	2,3	3	6,8	2	4,5	4	9,1	10	22,7			
	Agree strongly	0	0,0	0	0,0	5	11,4	27	61,4	32	72,7			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			
In their various roles in developing software systems, software engineers have significant opportunities to do good or cause harm.	Disagree strongly	0	0,0	0	0,0	1	2,3	0	0,0	1	2,3	6.157	9	0,7241
	Disagree somewhat	0	0,0	0	0,0	0	0,0	1	2,3	1	2,3			
	Agree somewhat	0	0,0	1	2,3	3	6,8	8	18,2	12	27,3			
	Agree strongly	1	2,3	2	4,5	4	9,1	23	52,3	30	68,2			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			
Software engineers have a general obligation to consider the ethical implications of their systems.	Disagree strongly	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	9.598	3	0,0223
	Disagree somewhat	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0			
	Agree somewhat	0	0,0	1	2,3	5	11,4	4	9,1	10	22,7			
	Agree strongly	1	2,3	2	4,5	3	6,8	28	63,6	34	77,3			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			
The software engineering industry needs its own set of professional ethics that focus on the issues relating to software development.	Disagree strongly	0	0,0	0	0,0	0	0,0	1	2,3	1	2,3	15.922	9	0,0685
	Disagree somewhat	0	0,0	0	0,0	2	4,5	1	2,3	3	6,8			
	Agree somewhat	1	2,3	2	4,5	4	9,1	5	11,4	12	27,3			
	Agree strongly	0	0,0	1	2,3	2	4,5	25	56,8	28	63,6			
	Total	**1**	**2,3**	**3**	**6,8**	**8**	**18,2**	**32**	**72,7**	**44**	**100,0**			

cent indicated that the code of ethics was important. However, 4,5 per cent and 2,3 per cent of the 77,3 per cent participants mentioned that the SWECoE was somewhat important and not important, respectively. Table 4 shows that 22,7 per cent of the respondents agreed somewhat that software engineers have an obligation to consider the ethical implication of their products. With regard to these respondents, 9,1 per cent and 11,4 per cent of them mentioned that the software engineering code of ethics was very important and important respectively to educators. The remaining 2,3 per cent of the 22,7 per cent indicated that the code was somewhat important to lecturers.

The Pearson Chi-square association test given in Table 4 shows a statistically significant association between *the importance of a software engineering code of ethics to a lecturer* and *the obligation for SEs to consider the ethical implications of their systems*. The p-value of 0,0223 of the association test on the two variables indicates that there is a statistically significant association between the two variables. The association results mean that the participants who regarded SWECoE as important to lecturers also considered SEs obligated to observe the ethical implications of their systems.

The need for professional ethics in the software industry

Table 4 shows that the majority (63.6%) of the respondents were convinced (agreed strongly) that the software industry needs its own set of professional codes of ethics. At the same time, 56,8 per cent of the 63,6 per cent perceived SWECoE to be very important to educators, while the remaining percentage of the 63,6 per cent responded as follows: 4,5 per cent considered the code to be important, and 2,3 per cent viewed it as somewhat important to educators. The survey results also show that 27,3 per cent of the participants agreed somewhat that the software industry is in need of its own professional code of ethics. Of these participants, 11,4 per cent and 9,1 per cent regarded SWECoE to be important and very important to lecturers, respectively. On the other hand, the other 4,5 per cent and 2,3 per cent of the 27,3 per cent of the participants stated that SWECoE was somewhat important and not important to educators, respectively.

Table 4 also shows that 6,8 per cent of the respondents disagreed somewhat with the idea of the software industry needing its own set of codes of ethics. However, 2,3 per cent of the same participants considered SWECoE to be very important to educators, while the other 4,5 per cent of the 6,8 per cent regarded SWECoE to be important to educators Only 2,3 per cent of the participants disagreed strongly with the statement on the software industry in need of its own code of ethics. Interestingly, all the 2,3 per cent of participants considered SWECoE to be very important to educators.

DISCUSSION OF RESEARCH RESULTS

According to the results, the majority of the participants perceived SWECoE to be either very important (72,7%) or important (18,2%) to educators in the field of computing. This shows that they placed a high value on the SWECoE in assisting in guiding software practitioners in ethical decision-making processes in their work. Our finding contradicts a study by Taajamaa et al. (2018), which established that SEs considered a code of ethics unimportant (ethics was ranked last in the category of skills that were considered important by SEs). Our study also shows a statistically significant association between *sex* and *the responses to the question on the importance of software engineering code of ethics to lecturers*. The male participants considered a software engineering code of ethics more important to lecturers than did their female counterparts. This indicates that males were more likely to be guided by the software engineering code of ethics when an ethical decision was needed. We ought to point out, though, that there was an unbalanced representation of males versus females in the participants – males had 77,3 per cent representation, while females had only 18.2 per cent representation. Our results here contradict the findings of a study by Taajamaa et al. (2018), which established that women regarded ethics as more important than the men. The same study did not find any significant difference in the younger generation on the same issue and therefore stated that the results were inconclusive.

The results also show that the majority of lecturers considered teaching students a code of ethics as important. This outcome implies that lecturers regard SWECoE as an important tool in "regulating" and guiding the ethical behaviour of SEs in software development. However, this perceived expression of the importance of ethics codes by the lecturers does not seem to be reflected in the curricula of the software development programmes, as established by a study carried out by Marebane and Hans (2021, 589). The referred study found that the SWECoE did not receive sufficient coverage in computing curricula of South African universities of technologies. The association test results also indicated a significant association between the responses of those who considered teaching a software engineering code of ethics to students and those who regarded a software engineering code of ethics as important to computing lecturers. This means that the educators who viewed a code of ethics as important to lecturers were more likely to teach students the importance of a software engineering code of ethics.

The majority of the participants showed appreciation for both the good and harm that software products may cause in society. This understanding of potential harm or good that software products may cause seems to be an acknowledgement of the need for the code of ethics to mitigate the risk of harm, maximising the positive risk (the good). This observation is

confirmed in the discussion related to *the need for professional ethics in the software industry* measurement. Therefore, this finding shows that the participants understood the important role that a code of ethics could play in helping SEs behave ethically.

All respondents agreed (even though a few (22,73%) of them *agreed somewhat*) that software engineers have an obligation to reflect on the ethical impact of their software products. This signals that educators understand that software products should behave (function) ethically. This may be made possible by having software engineers acting ethically in the software development process. Pierce and Henry (1996, 434) established that codes of ethics (especially professional codes of ethics) play a critical role in guiding SEs' ethical decision-making. Moreover, since the educators consider the impact of the products of SEs important, they expect SEs to act ethically (Leonard, Cronan, and Kreie 2004, 153) in the process of developing software systems. The educators' understanding of the importance of the ethical impact of SEs' systems is also reflected in their (majority) acknowledgement of teaching students (future SEs) ethical behaviour, as discussed above. The research results also indicate a statistically significant association between the responses of those who viewed a software engineering code of ethics as important to lecturers and those who believed that SEs had an obligation to consider the ethical implications of their systems. This means that the educators who considered the SWECoE important to them were likely to teach their students to produce ethical software systems.

The research results show that the vast majority (just over 95%) of the respondents indicated that the software industry needs its own code of ethics. This suggests that the code of ethics for software engineers is necessary and important for guiding the ethical behavioural conduct of SEs. This finding is consistent with Pierce and Henry's (1996, 434) finding, which indicates that software professionals have considered professional codes important in guiding their conduct, especially during ethical decision-making.

CONCLUSIONS AND RECOMMENDATIONS

This study's aim was to establish the perceived importance of a software engineering code of ethics by educators from two computing departments of a South African university of technology. The discussion presented in the previous section demonstrated that the educators considered a software engineering code of ethics important. This conclusion is based on the five measurements used to gauge the perceived level of importance as presented in the research results section. The research results show that: (i) the participants clearly indicated the significance of the software engineering code of ethics to educators. The study also established that males regarded a code of ethics more important than did their female counterparts; (ii) the

educators understood the possible harm or good that software products may have on society; (iii) the respondents unanimously indicated that SEs have an obligation and responsibility to consider the ethicality of their software products. The study also found that the educators who considered SWECoE important to them also felt that SEs are obligated to consider their systems' ethical implications. (iv) the overwhelming majority of the educators emphatically specified that there was a need for a professional code of ethics for the software industry; and finally, (v) the educators considered the teaching of ethics to students important, even though this perceived level of importance did not match the coverage of ethical issues in their computing programmes.

Previous studies have shown that awareness of codes of ethics is necessary but not a sufficient deterrent for unethical behaviour. The perceived importance is also useful in the equation of determining ethical or unethical behaviour. The high regard for the code of ethics also determines the level of commitment toward teaching ethics to students. Therefore, it was important to establish the value attributed to a software engineering code of ethics by educators.

Even though a very significant number of educators indicated the need for a code of ethics for the software industry, the need for SEs to be mindful of the potential harm that their products may cause to society, and the importance of teaching students a code of ethics, some (a total of 6 educators) did not agree with the majority. No matter how insignificant the number of those who disagreed, the fact that these are educators who wield much influence over students (students expect lecturers to set high ethical standards (Saat, Jamal, and Othman 2002, 118)), this should be of concern. The study recommends that the institution consider finding a permanent way of inculcating a culture of ethical conduct amongst its staff members. Educators should also be encouraged to take up professional memberships with professional bodies, which demand ethical behaviour from their members. This will ultimately transcend to the teaching of software development students about ethics and the adoption of professional codes of ethics as part of the teaching material.

LIMITATIONS AND FUTURE STUDIES

This study has some limitations, as with most other studies. The first limitation concerns the issue of self-reporting from the respondents – the results of a study which uses self-reporting are open to bias. Secondly, since the study is case-based (the results are based on two computing departments of one UoT), its findings may not be generalised. However, this limitation provides an opportunity for further investigation of the findings of this study.

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