THE ETHICAL UNDERSTANDING OF ENTRY LEVEL ENGINEERING AND COMPUTER SCIENCE STUDENTS

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ABSTRACT

Ethics is considered an essential aspect of tertiary computer science and engineering education and forms a core part of professional accreditation for degree providers. The authors have been unable to locate a study in New Zealand on computer science and engineering students' ethical beliefs, making this study an important exploration in this field. This study investigates the incoming first-year

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cohort's beliefs and understanding of ethical issues across three areas: students, future employees and members of society. We conducted the study over two consecutive years to investigate cohort beliefs. For most questions, the students provided high ethical responses, except in the areas of "software piracy and copyright" and "misuse of computer resources". In one year a small but significant number of female students indicated very low agreement that plagiarism is unethical. This research identified the importance of gaining an insight into student ethical beliefs as cohorts can differ in opinions. The findings challenge the common practice of teaching the same material over multiple years with the recommendation that teaching is adapted to address differences in students' ethical beliefs.

1   INTRODUCTION

1.1 Background

In both engineering and computer science education there is a recognised need by professional bodies and tertiary institutions to educate students in ethical responsibility and reasoning [1]–[3]. Despite this goal, the international literature indicates that there is widespread differences in approach and limited evidence on the effectiveness of many existing curricula [4]–[5]. In the New Zealand case there is no significant body of literature that looks at effectiveness of teaching, students ethical beliefs, or relevant context.

Our School of Engineering and Computer Science programme at Victoria University of Wellington, New Zealand (VUW) teaches a Bachelor of Science (BSc) and Bachelor of Engineering with Honours (BE) in digital technology fields. There is no instruction on ethics in the first-year programme and both degrees share many technical courses. Ethics education within our programme is primarily delivered via second- and fourth-year professional engineering courses in the BE.

2   METHODOLOGY

2.1 Survey, Data Collection and Analysis

This study aims to identify the strength of ethical belief of our incoming BSc and BE students from three perspectives: as students, as employees and as members of society - asking from different viewpoints allows identification of features in the responses indicative of the character of student understanding of ethical issues. We used a modified version of the survey instrument developed to assess ethical perceptions by Omosalewa Aderonmu, Cheryl Aasheim, and Paige Rutner, from Georgia Southern University, USA [6]. The full survey can be found here: https://bit.ly/35wjty4. The VUW ethics committee approved this research (ref. 0000027448). Questions are grouped into the three perspectives and responses are requested on a 5 point Likert scale where 1 is "strongly disagree" and 5 is "strongly agree". Table 1 in section 3 lists the survey questions. The surveys were distributed in paper form in the courses COMP103 "Introduction to Data Structures and Algorithms" in trimester 2 of 2019 and in COMP102 "Introduction to Computer Program Design" in trimester 1 of 2020, within the first three weeks of the courses.

These courses were chosen because all BE and BSc students are required to pass both of these courses. The response rate was 45% in both years and the results were manually entered into Qualtrics [7]. In our analysis we divide responses into "buckets" with scores of 4 and 5, indicating positive agreement with the ethical position described in the questions, while grouping responses in the range 3 – 1 into a "bucket" indicating the student needs ethical education ("needs education").

3   RESULTS

3.1 Average responses on the Likert scale

How a student answers the survey questions, as a student, employee or member of society, reveals their ethical understanding. The overall results indicate generally high (> 4.0) average agreement with the ethical statements, but differences between responses within each viewpoint reveals evidence of ethical relativism on issues which should be important for students studying toward careers in digital technology. Table 1 shows the average response to each survey question in 2019 and 2020 surveys; the full results of the surveys are available online.

Table 1. Average responses to questions in 2019 and 2020

Question	Text	2019	2020
As a student I believe it is unethical to:			
Q6.1	Take credit for someone else's work	4.5	4.5
Q6.2	Hire someone to write an essay	4.5	4.3
Q6.3	Purchase or submit a research or term paper from the internet to a class as one's own work	4.6	4.5
Q6.4	Cheat on a graded assignment	4.5	4.5
Q6.5	Cheat on an exam	4.5	4.5
Q6.6	Plagiarize other people's work without citing or referencing the work	4.4	4.4
Q6.7	Add the name of a noncontributing person as an author in a project/research study	3.9	4.0
Q6.8	Copy and paste material found on the Internet for an assignment without acknowledging the authors of the material	4.1	4.3
Q6.9	Deliberately provide inaccurate references for a project or research study	4.2	4.3
Q6.10	Knowingly permit student work done by one student to be submitted by another student	4.2	4.4
As a student I believe it is unethical to			
Q7.1	Surf the internet for personal interest and non-class related purposes during classes	2.4	2.6

Q7.2	Make a copy of software for personal or commercial use	3.2	3.2
Q7.3	Make a copy of software from a friend	3.0	3.1
Q7.4	Download pirated software from the internet	2.8	3.4
Q7.5	Distribute pirated software from the internet	3.2	3.7
Q7.6	Buy software with a single user license and then install it on multiple computers	3.6	N/A
Q7.7	Share a pirated copy of software	3.3	3.6
Q7.8	Install a pirated copy of software	3.2	3.3
As an employee I believe			
Q8.1	Providing unauthorised access to other people's personal information to be unethical	4.7	4.7
Q8.2	I have an obligation to respect and protect the integrity of intellectual property and confidentiality agreements	4.5	4.6
Q8.3	Using social media networking as a tool for cyber bullying to be unethical	4.6	4.6
Q8.4	It is unethical, and potentially unlawful, to take an unathorised copy of someone else's work	4.5	4.5
Q8.5	Ethical behaviour is better understood by students in your major than students in other majors	2.8	3.0
Q8.6	Education has an influence on one's ethical behaviour	4.0	3.8
Q8.7	Being ethical is important in the information technology sector	4.4	4.4
As an employee I should			
Q9.1	Not disclose confidential organisational information to co-workers without authorisation	4.6	4.6
Q9.2	Uphold and abide by the laws, code of conduct, ethical and moral principles of my organisation	4.6	4.6
Q9.3	Not violate the privacy and confidentiality of information entrusted to me to further personal interest	4.7	4.7
Q9.4	Not surf the internet for personal interest and non-work related purposes at work	3.3	3.4
Q9.5	Not involve in the act of phishing (unathorised stealing of people's valuable data)	4.8	4.8
Q9.6	Not involve in the act of email spoofing (deformation of email phishing purposes)	4.7	4.8
Q9.7	Not violate other people's privacy with the use of internet	4.7	4.7

	monitoring devices		
Q9.8	Not use technology to infringe on other people's privacy rights	4.7	4.7
Q9.9	Adhere to strict confidentiality rules regarding privacy and proprietary matters	4.7	4.6
As a member of society, I should			
Q10.1	Advise in an honest and trustworthy manner to enable people to behave ethically	4.5	4.4
Q10.2	Be ethical in my behaviour in all aspects of life	4.3	4.3
Q10.3	Protect fundamental human rights	4.7	4.6
Q10.4	Respect the diversity of all cultures	4.7	4.6
Q10.5	Abide by and not violate the laws of the country and community	4.4	4.5
Q10.6	Not misuse computing or technology resources	4.3	4.3
Q10.7	Report and violations of ethical regulations to an authority	4.1	4.2
Q10.8	Protect against the act of piracy (downloading or copying copyrighted music/video/books/software or any electronic materials)	3.4	3.5
Q10.9	Take action if I catch someone involved in unethical use of computing resources	3.6	3.8
As an employee, I believe			
Q11.1	Establishing an organisational code of ethical standards encourages employees in that organisation to behave ethically	4.2	4.3
Q11.2	Establishing a code of ethics for professionals encourages professionals to behave ethically	4.3	4.3
Q11.3	Students acquire and develop their ethical standards by taking ethics as part of the curriculum	3.6	3.6
Q11.4	Ethical standards are important in programmes. Ethical standards should always be included in the curriculum	3.8	4.0

Questions 6 and 7 ask, from the perspective of a student, for an assessment of matters related to academic integrity and software piracy and copyright violation. The contrast in responses is stark: most Q6 responses are greater than 4.1 while most Q7 responses are less than 3.7; the distributions are explored in detail in section 3.2.

Questions 8 and 9 ask for the ethical perception from the perspective of an employee, regarding obligations to society and their employer with respect to privacy, confidentiality, copyright, intellectual property, and ethical behaviour. These two questions consistently received the highest average responses. Both cohorts rate the ethical understanding of their peers in other majors as neither better nor worse than their own (Q8.5 "neutral" 3.0 average.) The influence of employment vs.

academic context may also be seen in the results of question set 11 regarding codes of ethics, where higher average responses are given to organisational importance (Q11.1, Q11.2) than academic importance (Q11.3, Q11.4).

Question 10 is asked from the perspective of a member of society regarding personal behaviour. The majority of responses to these questions indicate a sentiment of high ethical obligation to society from both cohorts. The exceptions are questions 10.8 and 10.9, regarding copyright violation and the unethical use of computing resources, and are notable because they are consistent with context-sensitivity displayed in the lower average responses to Question 7.

Ethical relativism is where ethical belief is attributable to context, be it cultural or social norms while in contrast, ethical absolutism holds that ethical situations have definitive answers regardless of context [8]. The absolutist response to the survey would be "strongly agree" to every question. We find in the results consistent ethical relativism related to the personal identity as a student, reflecting the students understanding of social norms in their peer group. This relativism is most pronounced in question set 7 but also discernible in several other questions, for example, a reluctance to report peers visible in the response to Q10.9, or the different average responses to Q6.1 and Q6.7 which ask the same fundamental ethical question. The dichotomy seen in the average responses to question set 11 is also consistent with a relativist interpretation that ethical understanding is acquired in the context of employment rather than learned in an academic context.

3.2 Distribution of ethical sentiment within the Likert scale

Question Q6.7 was identified receiving the lowest average response in the Question 6 set regarding academic integrity, despite its close relationship to Q6.1. Question Q6.1 asks whether it is unethical to <u>take</u> credit for someone else's work while Q6.7 effectively asks whether it is unethical to <u>give</u> credit for someone else's work. Both are violations of academic integrity by the misrepresentation of authorship. The distribution of responses for these two questions is revealing and are shown in Table 2. In both years 90% of students agree, with around 80% strongly agreeing, with the statement that taking credit for someone else's work is unethical. In contrast, around only 37% – 43 % of students strongly agree with the statement that giving credit for someone else's work is unethical and 26% – 30% are neutral or disagree. Question Q6.7 provides an example of clear differences in response between the 2019 and 2020 cohorts, with a shift of around four percentage points toward stronger sentiment that "gift authorship" is unethical in the 2020 cohort.

Table 2. Distribution of responses for Questions 6.1 and 6.7 in 2019 and 2020

Question 6 As a student I believe it is unethical to:	Bucket	2019	2020
Q6.1 Take credit for someone else's work	Needs education	10.8%	11.0%
	Somewhat agree	8.9%	11.0%

	Strongly agree	80.4%	78.0%
Q6.7	Needs education	30.4%	26.0%
Add the name of a noncontributing person as an author in a project/research study	Somewhat agree	32.9%	31.5%
	Strongly agree	36.7%	42.5%

This is perhaps the single strongest result pointing toward ethical relativism by first-year students and indicates that further education is required for both cohorts on this specific aspect of academic integrity, particularly in degrees such as the BE which place emphasis on group project work.

Question set 7 received consistently low average responses compared to all other question sets, and the distribution of responses is shown as Table 3.

Table 3. Distribution of responses for Question 7 in 2019 and 2020

Question 7 As a student I believe it is unethical to:	Bucket	2019	2020
Q7.1 Surf the internet for personal interest and non-class related purposes during classes	Needs education	82.8%	80.2%
	Somewhat agree	14.0%	12.7%
	Strongly agree	3.2%	7.1%
Q7.2 Make a copy of software for personal or commercial use	Needs education	56.4%	63.2%
	Somewhat agree	26.9%	20.0%
	Strongly agree	16.7%	16.8%
Q7.3 Make a copy of software from a friend	Needs education	62.6%	60.8%
	Somewhat agree	27.1%	22.4%
	Strongly agree	10.3%	16.8%
Q7.4 Download pirated software from the internet	Needs education	65.4%	50.8%
	Somewhat agree	24.4%	27.8%
	Strongly agree	10.3%	21.4%
Q7.5 Distribute pirated software from the internet	Needs education	60.5%	43.7%
	Somewhat agree	19.7%	21.4%
	Strongly agree	19.7%	34.9%
Q7.6 Buy software with a single user license and then install it on multiple computers	Needs education	40.8%	N/A
	Somewhat agree	24.8%	N/A
	Strongly agree	34.4%	N/A
Q7.7 Share a pirated copy of software	Needs education	51.0%	43.7%
	Somewhat agree	24.8%	27.0%
	Strongly agree	24.2%	29.4%

Q7.8	Needs education	58.3%	56.3%
Install a pirated copy of software	Somewhat agree	21.2%	23.0%
	Strongly agree	20.5%	20.6%

Almost every question received a response indicating neutrality or disagreement with statements that software piracy is unethical from more than 50% of respondents. The only exception is Q7.6 in the context of licensing – a legal term – where only 40% or respondents are neutral or disagree that violating the terms of a software license is unethical. In 2019 only around 10% of respondents indicated strong agreement with the statements "as a student I believe it is unethical to download pirated software from the internet" and "as a student I believe it is unethical to make a copy of software from a friend."

These sentiments are incongruent for students to hold, whose career pathway is employment in the software industry in which their livelihood will depend on compliance with legal and ethical obligations to observe software copyright and licensing. Some awareness of this issue is revealed in the responses to questions Q8.2, Q8.4 and Q8.7 as employees while apparently not applying to themselves in the academic context [9]-[10]. Identifying this manner of ethical reasoning in the students indicates that significant classroom discussion of ethical relativism [8] should be incorporated into the professional engineering courses for these cohorts.

A trend of a small but significant number of female students responding with very low scores on the ethical understanding of "plagiarism" was observed in the 2020. For example, Q6.6: in 2019 there were 115 respondents identifying as male and 39 identifying as female, of whom 6.7% and 5.1% "strongly disagreed" with the ethical statement. In 2020, 84 respondents identified as male and 40 as female, of whom 3.4% and 17.1% "strongly disagreed" with the statement. Other questions in this set showed a similar relatively high "strongly disagree" response from female students in 2020, with differences statistically significant at the $p=0.05$ confidence level. A complete statistical analysis of this trend is unfortunately beyond the scope which can be accommodated by this Research Paper.

4   SUMMARY

We find evidence in the survey results consistent with relativist ethical reasoning [8], particularly in relation to software piracy and copyright violation [9]-[10]. Our professional engineering courses teach the same ethics material over multiple years from a predominantly absolutist perspective – which student relativist reasoning perceives as less effective (Q11.3; Q11.4). We recommend, and will implement in our courses, that teaching is adapted to address incoming students' surveyed ethical beliefs. It is clear from the data that our courses need to address the idea that ethical understanding is equally important across the three boundaries: student, employee and member of society. Our courses must address the connection between being a student and an IT professional and in doing so it may be possible to utilise the discussion around ethical relativism as a means of exploring ethical case studies.

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