Ethical Demand and First Year Civil Engineering Study: Applying Virtue Ethics

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ABSTRACT

Incidents within the civil engineering profession (structural collapses, collusion and the like) draw attention to the need for ethical conduct on the part of civil engineering practitioners. This manuscript explores ethical action in first year civil engineering study. This is done to discuss the role of universities in the development of civil engineering graduates with a critical awareness of the need for ethical action. The manuscript uses Alasdair MacIntyre's virtue ethics to theorize first year student actions during a practical exercise in concrete mix proportioning. Three aspects of ethical action emerged from observation of the students' completion of this practicum: corner-cutting, erroneous reporting, and misrepresentation of knowledge and ability. The manuscript argues that ethical behavior should be nurtured and discussed throughout the undergraduate degree, so that students are more likely to practice ethical behavior after graduation. There is thus opportunity to better integrate consideration of ethical responsibility into the undergraduate curriculum, and to shift the focus of higher education away from 'external goods' to the good of the profession and the communities it serves.

ETHICAL DEMAND AND FIRST YEAR CIVIL ENGINEERING STUDY: APPLYING VIRTUE ETHICS

INTRODUCTION

In recent years, the engineering and built environment sector in South Africa has been negatively affected by various scandals and structural collapses. For example, in the early 2010s, it was revealed that the South African construction industry had been engaged in collusion and price-fixing regarding the development of large-scale infrastructure development projects, including five stadiums built for the 2010 FIFA World Cup (Benjamin 2013). This involved anticompetitive practices in which large construction companies divided projects amongst themselves, and greatly inflated prices. In addition, in November 2013, a section of a mall in Tongaat, close to Durban on the South African east coast, collapsed, killing two people and injuring 29 others (eNews Channel Africa 2016). Media reports suggest that the concrete strengths of several parts of the mall were below standard, possibly leading to the failure of at least one beam and one foundation (SABC 2014; Africa News Agency 2015). More recently, a temporary bridge structure collapsed over a busy highway in Johannesburg, the economic center of South Africa. This collapse killed one person and injured several others (Corke n.d.); again, there have been various allegations of short-cuts, and concerns raised prior to the collapse of the bridge (Mutizwa and Brown 2016; Corke n.d.).

Although these three incidents are unrelated, they nonetheless draw attention to the importance of ethical conduct on the part of, amongst others, design and construction engineers. Furthermore, these issues are not only prevalent in South Africa, but are of global concern. Transparency International's most recent *Bribe Payers Index* ranks the construction sector as the most corrupt sector globally (Hardoon and Heinrich 2011). Indeed, the ethical challenges facing the global construction industry are becoming more complex, and more serious, as corruption, fraud, kickbacks and collusion become more commonplace (Liu et al. 2017). Of course, such actions are usually a product of multiple contributing factors that can be technical, human and organizational (Basart and Serra 2013; Liu et al. 2017). As such, they raise questions about the role of higher education institutions in preparing candidate engineers for the ethical demands of engineering practice.

This manuscript asks how ethics can be incorporated into the undergraduate engineering degree curriculum. It addresses this question by deploying a particular philosophical approach to ethics, namely, Alasdair MacIntyre's notion of virtue ethics, which argues that people should recognize themselves as virtuous agents contributing towards ethical development within society. MacIntyre claims that "what matters […] is the construction of local forms of community within which civility and the intellectual and moral life can be sustained" (2007, 263). Within this approach, we argue that the ethical question to be asked, in cases where ethics fail, is not 'who is guilty', but 'how does each individual contribute to the situation' (Basart and Serra 2013). We apply this virtue ethics approach to the observed behavior of first year civil engineering degree students in a particular module on Concrete Technology.

The manuscript is structured such that it begins with discussion of the positioning of 'ethics' within the civil engineering curriculum and within the regulatory guidelines provided by, inter alia, the Engineering Council of South Africa (ECSA) and the Accreditation Board for Engineering and Technology (ABET). Thereafter, it introduces the notion of virtue ethics, and explains MacIntyre's specific approach to individual ethics. Finally, it discusses some of the conduct demonstrated by students as they were filmed completing a practical exercise in concrete mix proportioning. The conduct of students within the groups is framed within the lens of MacIntyre's approach to virtue ethics. However, this is not undertaken in order to label these students as 'unethical': rather, it seeks to raise questions about the role of higher education institutions in promoting critical awareness of the need for ethical conduct, and preparing students for the ethical demands of the construction industry.

ETHICS IN ENGINEERING EDUCATION

Inspection of engineering degree curricula in South Africa reveals that while most programs include content related to ethical conduct, this content is usually presented in the form of an isolated module in 'Professional Practice' almost always at final year level. Similarly, in the United States, Carpenter et al. (2014) identify what they call the 'bookend' effect, where ethics instruction is most common in introductory and/or senior-level modules. There are thus few attempts at the embedded development of ethics within the curriculum and, where such attempts do exist, they are often stymied by limitations of time, resources and training (Beever and Brightman 2016). Also, internationally, there is great variation in the quality and type of ethics instruction that is given to undergraduate engineering students, with little consensus as to what the objectives of such instruction should be (Keefer et al. 2014).

Furthermore, the development of engineering students as ethical practitioners has been given little attention in the literature (Bairaktarova and Woodcock 2015). This dearth of literature is startling as both the standard for registration as a professional engineer in South Africa (ECSA 2012) and the qualification standard for engineering degree programs (ECSA 2014) include requirements relating to ethical conduct. The ECSA qualification standard states that all engineering degree program graduates must "demonstrate critical awareness of the need to act professionally and ethically and to exercise judgment and take responsibility within [their] own limits of competence" (ECSA 2014, 7). Similarly, the ABET requirement is that students demonstrate "an understanding of professional and ethical responsibility" (ABET n.d.). Furthermore, in South Africa, the engineering code of conduct states that professional engineers should discharge their duties with due diligence, should not misrepresent their competencies, should be honest and factual in their decisions and recommendations, should ensure the correctness of any work that they sign off on and should, at all times, give due regard to health and safety and the interest of the public (ECSA 2013).

However, these documents have little to say regarding how higher education institutions should incorporate these issues. Indeed, they are intentionally non-prescriptive, allowing engineering schools and departments to determine for themselves how best to achieve the required student outcomes. Nonetheless, the ECSA qualification standard indicates that evidence of the development of ethical conduct can be found in the use of "case studies typical of engineering practice situations in which the graduate is likely to participate" (ECSA 2014, 7). Some of the literature supports this assertion: for example, Alpay (2013) contends that case studies enhance the perceived relevance of ethics education in engineering, while Abaté (2011) argues that the study of cases will develop the philosophical skills required to resolve similar ethical dilemmas in the future.

While such case studies may be of significant value in drawing students' attention to the implications of unethical conduct, our observation is that they do not require that students demonstrate ethical conduct during their time at university. The use of case studies is limited

(Beever and Brightman 2016) in that they are afforded little time in the curriculum and are often grossly simplified and studied out of context (Basart and Serra 2013; Reid 2012). This is exacerbated by the fact that few engineering academics necessarily have the required insight to identify ethical paradigms or the philosophical tools to conduct clear and rational ethical deliberation (Abaté 2011). And, it is further exacerbated by the fact that students tend to commit less time to studying for ethics courses (Dabbour 2016).

ECSA's exit-level outcome for engineering degree programs states that students must *demonstrate an awareness* of the need for ethical conduct but this does not necessarily require students to *be* ethical in their everyday activities. We would argue, as Carpenter et al. (2014) have done, that there is a difference between knowledge of ethics, ethical reasoning, and ethical behavior, and that developing knowledge *of* ethics does not necessarily promote ethical reasoning, or ensure students exhibit ethical behavior (Carpenter et al. 2014). There is thus a need for institutions of higher education to assist students in developing an awareness of themselves as ethical actors who are more likely to act responsibly and in the interest of society after graduation.

Consideration of the responsibility of institutions of higher education is particularly important as an individualistic account of ethics is limited by the fact that solutions to ethical problems often require changes in the context in which engineers work (Conlon and Zandvoort 2011; Liu et al. 2017). The engineering professions possess macro-ethical issues that require the resources of both individual engineers and their organizations and professional bodies to resolve (Conlon and Zandvoort 2011). It is thus clear that the development of engineering ethics extends beyond the purview of the higher education institutions. Nonetheless, these educational institutions must still participate in the development of engineering professionals that are more likely to "play an active role in reshaping the environment in which they work" (Conlon and Zandvoort 2011, 229).

VIRTUE ETHICS AND MACINTYRE'S APPROACH

Ethics, as a field in Philosophy, involves identifying and categorizing actions or behavior as right or wrong. There are three major branches of ethical theory: metaethics, applied ethics and normative ethics (Hursthouse 2013). While each of these branches focuses on specific aspects of ethics, normative ethics, in particular, advocates the practice of ethical behavior and identifies the ways in which people ought to behave. One major approach found within normative ethics is virtue ethics, which "[m]any scholars contend…offers great promise for developing 'emotional engagement' with ethics in engineering students" (Troesch 2015). Generally, students are able to intellectually engage with the *idea* of ethics, which means they are able to identify ethical approaches and are able to develop responses to case studies, that is, they have knowledge of ethics. However, being able to intellectually engage with the idea of ethics does not necessarily mean a student is in the position to emotionally engage with the idea of ethics. Emotional engagement involves the ability to recognize ethical issues, as well as the capacity to care about and address these issues (Troesch 2015). While it might be that metaethics and applied ethics focus primarily on intellectual engagement, normative ethics appears to assist in the development of emotional engagement with ethical issues. Therefore, this manuscript focuses on a normative approach, namely virtue ethics.

Virtue ethics can be understood as an approach that emphasizes moral or virtuous character, as opposed to other forms of ethics which emphasize the rules of ethics or the ethical consequences of actions (Harris 2008). Persons who advocate duties and rules as a form of ethics stipulate that the need to help someone, for example, is done from the perspective that to help that person is a moral obligation or rule (Jordan 2006). Whereas, a consequentialist may examine the possible results of helping a person and, from this, determine its ethical validity based on how it will affect themselves and others. However, a person who practices virtue ethics will help a person because they are intrinsically virtuous rather than helping a person based on a set of rules or consequences. Therefore, virtue ethics focuses largely on the development of a self that is intrinsically virtuous (Hursthouse 2013).

MacIntyre explores the concept of virtue ethics in relation to the self within a particular community or society. In *After Virtue: A Study in Moral Theory*, MacIntyre develops the notion of virtue ethics by focusing on three main virtues, namely, justice, honesty and courage (MacIntyre 2007). According to MacIntyre, a person is virtuous when they possess and exhibit these three virtues. However, for MacIntyre, it is important to note that these virtues are not practiced by an individual in isolation; rather, they are practiced within a societal context (MacIntyre 2007). Furthermore, it is this realization, that an individual plays an important role in the development and sustainability of a moral society, that encourages individuals to embrace virtuous behavior or action.

Despite this, Macintyre (2007) argues that society appears to be in a moral vacuum, that is, that morality has been dislodged as an important feature of everyday behavior, replaced instead by emotivism. Emotivism focuses on classifying actions as good or bad, where this classification is based solely on opinion. Opinions are expressions of emotions and, as such, subjective (Wiggins 2010). That is to say, what one person considers good, another may consider bad: there is thus little shared consensus as to what is actually good or bad. Ayer (in Wiggins 2010, 181) claims that “judgements of value, insofar as they are not scientific statements, are not in the literal sense significant but are simply expressions of emotion which can be neither true nor false".

According to the virtue ethics perspective, to develop a more objective account of morality, an individual should consider embracing the concept of virtue. The identification of virtues and the implementation thereof serves three important purposes: 1) it allows the individual the perspective of themselves as virtuous agents; 2) it allows the individual to understand that their virtues matter in a societal sense and 3) it informs society of its moral status. As MacIntyre (2007, 219) points out, "virtues are anything which sustain the kind of households and the kind of political communities in which men and women seek for good together". This is relevant to engineering, because engineers operate within organizations in which various interests, stakeholders and boundaries interrelate (Basart and Serra 2013). Basart and Serra (2013, 181) continue:

> What engineers do and how they do it depends on all of these people, organizations, requirements and regulations. The quality of their work, the degree of responsibility they are willing to take, and the commitment to good service, are all under the influence of the elements named above. Engineers are not a singularity inside engineering; they exist and operate as a node in a complex network of mutual relationships with other nodes.

With this in mind, MacIntyre (2007) asserts that virtues are shared practices undertaken by, and for the good of, a given community. MacIntyre identifies two kinds of good: internal and external. Internal goods result directly from actions whereas external goods result indirectly from actions. Performing an action primarily with the aim of producing internal goods serves to 1) develop and 2) make use of virtues. That is to say, it is performed with the good of a given social community in mind.

Such ethical reasoning, and the notion of virtue, is of crucial importance to engineering because it is closely tied to issues of globalization, development, sustainability, and technology (Beever and Brightman 2016). According to the Engineering Council of South Africa (ECSA 2013), registered engineers must perform their duties under the banner of ethics which advocates competency and integrity. Almost all of the requirements found under this banner of ethics are relevant to virtue ethics. In particular, however, the following rules are directly related to what has been set out in this article regarding virtue ethics:

> Registered persons:
>
> a) must discharge their duties to their employers, clients, associates and the public with integrity, fidelity and honesty;
>
> c) must not engage in any act of dishonesty, corruption or bribery;
>
> h) must give engineering decisions, recommendations or opinions that are honest, objective and based on facts;
>
> l) must notify Council on becoming insolvent where such insolvency is caused by his or her negligence or incompetence in performing engineering work.

These 'rules' set out in the Code of Conduct represent the virtues that underpin engineering activity. That is to say, codes of conduct, such as this, reflect a "logical compatibility and consistency with certain principles of common morality" (Abaté 2011, 585). Despite this, some engineers nonetheless fail to adhere to these requirements, or virtues. In part, this may be related to the tertiary education they receive regarding the importance of ethics, where engineering students often perceive ethics as irrelevant (Bairaktarova and Woodcock 2015). It is for this reason that this manuscript considers the role played by institutions of higher education in promoting awareness of virtue in the practice of engineering.

IDENTIFYING OPPORTUNITIES FOR ETHICS INSTRUCTION: A DESIGN FOR RESEARCH

As already mentioned, this manuscript seeks to address the question of how ethics instruction might be incorporated into the undergraduate engineering degree curriculum. So far, this question has been addressed by considering perspectives from the relevant literature as well as the statutory bodies that oversee engineering education and practice. Moreover, a particular approach to ethics has been introduced. The remainder of this paper examines video-recorded data collected within a first year civil engineering module (on concrete technology) with a view to identifying instances in which focused ethics instruction could be provided.

This video data was collected at a large university in Johannesburg, South Africa, one that attracts a diverse student population from both urban and rural areas. The university offers a number of engineering qualifications, all of which are accredited by the Engineering Council of South Africa, in line with the requirements of the Washington, Sydney and Dublin accords. One of these qualifications is an accredited, four-year, professional degree in civil engineering.

As part of this degree, first year students complete a module called Concrete Technology, a semester module in the first year of the civil engineering degree program. The module includes a strong practical component, which is reflected both in the teaching of the module and in the assessment of students. This was necessary because the nature of concrete technology is such that it relies on practical knowledge and experience. One of the practical assignments that the students have to undertake is to perform two concrete mix proportioning exercises according to two separate, but commonly-used (in South Africa), approaches to concrete mix proportioning. This practical places emphasis on understanding the properties of both the constituent materials and the fresh concrete, and the effect of the constituent materials on the fresh concrete.

The practical was undertaken in groups of five. Students were supplied with all the necessary materials and equipment and, where applicable, were given the characteristics of the constituent materials. However, the students did have to calculate the mix proportion values needed for one of the approaches. The students were required to obtain a specified slump in both mixes and assess and compare the fresh properties of the concrete for each mix. Prior to the practicum, lectures were given in which the students were introduced to mix proportioning theory and procedure, including the procedures involved in conducting a slump test and the calculations required for the mix proportions.

All groups were asked to volunteer to be filmed, and those groups who came forward participated in this study. In total, twelve groups – each with five students – were filmed as they completed the assigned practical tasks. This represented approximately one-third of the total student cohort within the concrete technology module. In addition, the groups that volunteered were also filmed as they delivered a verbal presentation on the concrete mixes. The PowerPoint slides they used in their verbal presentation were collected as well as the written reports that the group members submitted. All students in these groups gave written permission for the filming to take place and had the opportunity to refuse to be filmed or withdraw from being filmed at any point. All students' participation in the project has been kept confidential.

The researchers then viewed all the video footage, in conjunction with the other data collected, making notes as they did so. These notes served as observations of points at which questions of ethics were evident in the students' completion of the practical task. It should be noted that, in the majority of the data obtained, the students' actions displayed a high level of ethical responsibility, while the instances discussed below represent isolated events. These isolated instances are reported upon not with the intention of labeling this minority of students as 'bad apples', but with the intention of explaining how these instances can be used as springboards for discussion about the importance of ethical action. Such discussion, we argue, is a cornerstone of incorporating ethics instruction throughout the curriculum, even in so-called 'technical' modules, such as concrete technology.

STUDENT ACTION AND VIRTUE ETHICS

Concrete mix proportioning is a process-governed activity in that there are strict procedures and protocols involved in the mixing of concrete and the assessment of fresh concrete properties. These procedures and protocols are designed so as to ensure the safety and fit-for-purpose of the concrete within structural elements. One of the methods undertaken in order to assess fitness for purpose is the slump test. The slump test is important to assess workability, cohesion and 'bleeding', amongst others. Performing the slump test and measuring the slump is important because the consistence of each batch of concrete placed inside a structure should be as similar to each other as possible (Kellerman and Croswell 2009; Owens 2013). The slump test also helps ensure that fresh concrete is able to be effectively handled, placed and compacted. Construction engineers thus need to understand the properties of fresh concrete and be able to visually assess these properties. The inclusion of the slump test in the first year module is aimed at introducing students to these properties and providing them with practice in the visual assessment of concrete. However, in order to benefit from this opportunity, students need to accurately, and honestly, carry out the test.

Some students did not fill the slump cone in three layers of approximately equal thickness; tamped the fresh concrete incorrectly, or an incorrect number of times; did not ensure that the slump cone remained stable on the base plate during completion of the slump test; did not measure the slump from the highest point; and recorded the slump value from an angle rather than horizontally. Of course, in each of these instances, these errors can be attributed to the fact that the students had not previously mixed concrete and, given that this was their first time doing so, they were liable to make such errors. In addition, given that they are new to the subject, they may not, as yet, fully understand the implications that these kinds of errors might have in concrete work. Nonetheless, in the discussion that follows, three observations pertaining to the students' actions are presented.

Corner-cutting

As already mentioned, because of the students' inexperience with concrete mixing, it was to be expected that numerous problems would emerge and mistakes made during the concrete mixing practicum. However, what was telling for the purposes of this discussion was the groups' decision-making processes. For example, few groups obtained the required slump on their first attempt with many not able to complete the slump test because of incorrect tamping and failure to pre-wet the base plate and slump cone. It is worth considering how the groups decided to either re-do the test, acknowledging their errors, or continue on, for the sake of expediency. In almost all the groups that faced this dilemma, there were members arguing for each of the options. In most instances, the groups made the decision to repeat the slump test.

Nonetheless, the fact that groups engaged in these debates shows the ease with which decisions can come to be made for the sake of expediency rather than the common good. For example, one student used the argument that it was Friday afternoon and that it would take too long to repeat the test. Of course, there is not necessarily a direct causal relationship between such cutting of corners at undergraduate level and the unethical actions that may occur in practice. However, we would argue that these moments of debate are ideal opportunities in which engineering educators can engage students in discussion of the importance of ethics in engineering practice and, in turn, engineering study.

This can be done, for example, by introducing the case of the Grayston Bridge collapse mentioned in the introduction to this manuscript. Mutizwa and Brown (2016) report that various short cuts (such as beginning construction before the building plans were completed) resulted in the failure of the bridge. From a virtue ethics perspective, it is worth noting that such a practice, although in contravention of international building standards, did not necessarily contravene South African standards (Mutizwa and Brown 2016). This illustrates the importance of virtuous action for the common good, even when no formal laws or procedures exist.

Decision-making regarding corner-cutting is of particular importance, as it bears direct relation to the engineering design process: engineering design involves a series of decisions and, as such, these decisions need to be guided by ethical principles and the common good at all times (Bero and Kuhlman 2011). A common decision-making practice undertaken by the students in the practical exercise studied herein involved discussion amongst group members, and the generation of consensus. This usually, but not always, led to an ethical course of action. These decision-making discussions represent students' ethical reasoning, and it is worth considering how these experiences can be harnessed for the purpose of the teaching and learning of ethics.

To illustrate this point, it was observed that students may cut corners for reasons that primarily consider immediate gratification for themselves (for instance, the student who wanted to leave early on a Friday). In such instances, it could be that the individual's own personal interest is more important than the overall achievement of the group. This illustrates the notion of emotivism, where individuals make subjective choices based on their own, personal goals rather than the good of a broader community which, in this particular instance, can be seen to be the group they were working within. That is, decisions came to "rest on a choice whose justification is purely subjective" (Aron 1967, 206).

From the perspective of MacIntyre's (2007) virtue ethics, if individuals have a common goal that acknowledges benefit to society, rather than benefit to the individual, it is possible that engineering ethics guidelines would be better adhered to. In other words, the processes and procedures developed should be undertaken with the good of the community in mind (Alpay 2013, 1456). When undertaking decision-making processes, students should be encouraged to see themselves as situated within communities with shared goals, rather than as individuals seeking to advance their own interests. Practical classroom instances such as this serve as valuable opportunities for engaging in such pedagogical conversations.

Inaccurate reporting

The video footage collected showed that some students inaccurately reported upon their actions in their verbal and written reports on the practical exercise. For example, one group paid no attention to the number of blows during the slump test, but reported, in the verbal presentation, that they had tamped each layer the required 25 times. Similarly, some students read a slump value that was outside that which was required but reported that they had obtained the required slump. In an even more telling example, one of the groups found that they had made a mistake in their calculations as their mix turned out too dry. Instead of re-doing their calculations, they added more water but neglected to track this additional amount of water, and also added further sand again without measuring the added sand. However, their verbal presentation reflected none of this. Instead, their presentation slides presented a corrected calculation and an indirect insinuation that that was how the mix was completed.

Again, while such mistakes are not, in themselves, problematic, given that the students are novice practitioners and that the repercussions of these decisions are minor, it is possible that the students may have demonstrated greater learning by acknowledging the errors they made and reflecting on how these errors may have impacted upon the properties of the fresh concrete. Errors should be seen as part of the learning process, but it may be the case that this is undermined by students' concern with external goods such as, in this case, the award of marks. It is likely that many students see the means (the processes to be followed) and the ends (the award of marks, and the notions of pass and fail) as separate from each other. However, both the means and the ends are important skills that students will need to integrate into their future development as engineers. The means enable them to complete their work, while the ends are a form of social feedback from the community that they seek to enter.

According to MacIntyre (2007), individuals need to understand their role in society, and to understand how their actions and their own development can affect the development of society. A practical example of this is the fact that, should a student continue to misrepresent their findings because they continue to erroneously perform procedures, that student will not acquire the skills and competencies necessary in the workplace. Those who do not recognize the way in which they contribute to the development of society, through the development of their own intrinsic virtues, may instead contribute to some of the negative issues currently facing the civil engineering profession (see collapse of structures, collusion, and the like).

This has prompted some to call for a “return to an emphasis on character in professional ethics instruction” (Walling 2015, 1639) in order to overcome the focus on external rewards and individual achievements. An individual should think of their actions as cumulative rather than as separate instances of behavior. When students view their actions as unique instances of behavior, they may come to believe that these are ‘once-off’ decisions that are not likely to be repeated and, therefore, they might be less likely to take full responsibility for those particular actions. The pedagogical implication of this is that assessment, particularly in instances such as this, should focus on accountability, rather than accuracy alone.

Misrepresenting knowledge and ability

Finally, it was also evident that a number of students misrepresented their knowledge and ability regarding mix proportioning. In numerous groups, a ‘leader’ would emerge who would direct the activities of the group. In some instances, this leader gave insightful direction and accurate feedback. However, there were some leaders that reported inaccurate information as if it was factual, because they were operating outside of the limits of their own competence. Failure to acknowledge the limits of one's own knowledge and competence can have disastrous implications in civil engineering practice, and it is for this reason that this is a cornerstone of the engineering code of conduct (ECSA 2013) and is also included in the ECSA exit-level outcomes (ECSA 2014).

Students in a group are more likely to align with a strong-minded, dominant, overconfident individual, regardless of that individual's beliefs or abilities (Nevicka et al. 2013). Sometimes, it might be that as long as the ends are met, the means to get there are of little concern to individual group members. This is because "whenever a complex undertaking is broken into separate parts, and the people assigned to work on these parts have a high degree of autonomy, the responsibility for the whole project begins to blur" (Basart and Serra 2013, 181). The reasons for this are that, generally, within group dynamics, the leader takes on the bulk of the decision-making and, therefore, the bulk of the responsibility.

A self-appointed leader, as was evident in the case of this practicum, is a person who tacitly maintains that they hold more knowledge and have greater abilities than the other group members. Thus, it is a natural development that other group members would place their trust in this supposed knowledge and acumen. Of course, this can be problematic if that leader is misrepresenting his or her knowledge and ability. The issue with this scenario is that the judgements are essentially criterion-less in that they are often based on personal considerations (MacIntyre 2007) and, as such, they might not be in the best interest of the group. Again, discussion of these instances with students, as they occur, is a valuable opportunity to promote ethical knowledge, ethical reasoning and ethical behavior, and can be used to foster the ability to critically interrogate voices of power.

CONCLUSIONS

Three observations have emerged from the students' actions during the mix proportioning practical. These relate to: cutting of corners; erroneous reporting; and the misrepresentation of individual knowledge and ability. The purpose of the practical exercise was to introduce students to the principles and procedures of concrete mix proportioning and give them practical exposure to the properties of the constituent materials within concrete as well as to the properties of fresh concrete. However, filming volunteer groups of students as they undertook the practical exercise assigned to them brought to light a number of ethical considerations indirectly involved in completion of the activity. In this manuscript, these ethical considerations have been discussed from the perspective of Alasdair MacIntyre's approach to virtue ethics.

These three instances demonstrate that there is ample opportunity, even within 'technical' modules, to embed ethics instruction. Civil engineering as a profession has a common goal that acknowledges the good of society. This is stated in numerous documents and speaks to the important role of civil engineering in nation building, sustainability and so on. The question remains, however, as to how to instill this common goal in the day-to-day activity of engineering professionals, as well as engineers-in-training, and the role that educational institutions might play in this regard. This is important because, as Chang and Wang (2011, 389) argue, "engineering ethics education is less about providing vast quantities of information and more about fostering lifelong scientific habits and an intrinsic motivation to innovate and excel at improving the human environment".

The ECSA Code of Conduct stipulates the importance of virtuous behavior, in MacIntyre's sense, within engineering practice. However, the first year students filmed for the purposes of this manuscript did not appear to relate their actions in the concrete mix proportioning practical to their future selves as civil engineering professionals. Of course, there is not a direct, causal relationship between what students do in a first year module, and the actions they take in their future careers. However, if students gain reward from engaging in 'corner-cutting', or indeed cheating, at first year level (and in subsequent years of study), such practices are more likely to continue after graduation. It is for this reason that Carpenter et al. (2014, 9) argue that "the way to encourage the greatest effect and strongest impact on students' ethical reasoning development is to concentrate on providing developmentally appropriate curricular experiences across all years". Such experiences should not be limited to designated 'ethics' courses, but can be introduced throughout the curriculum: in this manuscript, we note some of the ethical issues at play in a concrete mix proportioning practical at first year level.

It is thus possible that higher education institutions need to do more to tie student activities to the development of a future professional self that acts in the interest of society and the profession. This may require a re-examination of assessment practice within the undergraduate curriculum. This is because, at present, higher education appears to be premised on the award of external goods, in the form of marks and credits. The question needs to be asked as to how such a focus can be challenged so as to promote students' awareness of the need for their own development as ethical professionals. An answer to this question may be that institutions of higher education need to hold students to higher standards of ethical responsibility and embed ethical considerations throughout the curriculum.

Another answer may be that the current reliance on ethics case studies may be limited in its ability to promote awareness of the importance of ethical action.

However, a parallel answer, not addressed in this manuscript but worthy of future research, pertains to the issue of role models. The "characters" (MacIntyre 2007) that are found in modern societies often embody the attitude that one's own goals are of utmost importance and that others exist as a means to the end of achieving individual success. Institutions of higher education, and the staff within them, need to display ethical behavior in their own actions, such that the institution and its people serve as a role model for future civil engineering practitioners (Carpenter et al. 2014). Holsapple et al. (2012, 182) find that students often do not perceive lecturers as ethical role models and that, in order to mitigate this, lecturers, even when teaching topics other than ethics, "can draw on their own experiences describing ethical dilemmas they encountered and the positive ethical behaviors enacted when encountering the dilemma". MacIntyre argues that, all of us – student, practitioner or lecturer – can adopt a virtuous common goal and embrace our community-situated selves by directing our action toward the greater good.

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