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ASSESSING HIGHER EDUCATION STUDENTS' ETHICALITY

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ABSTRACT

In higher educational institutions, ethics is the very core of the people that institutions are trying to morally shape. In a few years' time, these students will be assigned to some work place where they will be forced to make decisions which can affect businesses and more importantly – human lives. In that respect, what seems like a simple doubt about right or wrong, becomes alarmingly significant and in times where economics and profit drive the thinking of the society, ethics are often overlooked. Universities attempt to instil ethical principles by providing courses on the topic, and through demonstrated behaviour of professors. This article presents introduction of a new class, devoted to ethics, as an application of stated approaches. The article shows some details of the class, with emphasis put onto the behaviour and decision that students showed during conducting given assignments. Findings have been divided into technical and ethical aspects.

KEY WORDS

engineering ethics, engineering education, metrology

CLASSIFICATION

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INTRODUCTION

Throughout their career professional engineers encounter a number of ethically doubtful decisions, and situations. With their behaviour they can influence further development of the decision or situation, i.e. they actively shape ethicality of the decision or situation they are participants of.

Although our view of what is and is not ethical is influenced by our families, involved communities, and other layers of society, engineering ethics are taught as part of engineering curriculum. This paper presents assessment of engineering students' ethicality by analysing student behaviour and decision making during their given assignments. Description of the assignment is presented prior to the discussion of the observations, while observations have been divided into technical and ethical aspects. Concluding remarks summarize the paper and findings.

ASSIGNMENT DESCRIPTION

Groups of students were given physical objects that were related to engineering and definitely seen before in their past classes (for example, steel plates).

Each group was given a task to measure some property of a given object to the best of their ability with the tools that were given by the professor and the assistant (Table). To further test their ethicality, a thermometer was also available for use. Temperature was an influential factor to 4 out of 6 laboratories. All of the laboratories were told to write down exact results, truthfully. Assignment organization chart is shown in Figure 1.

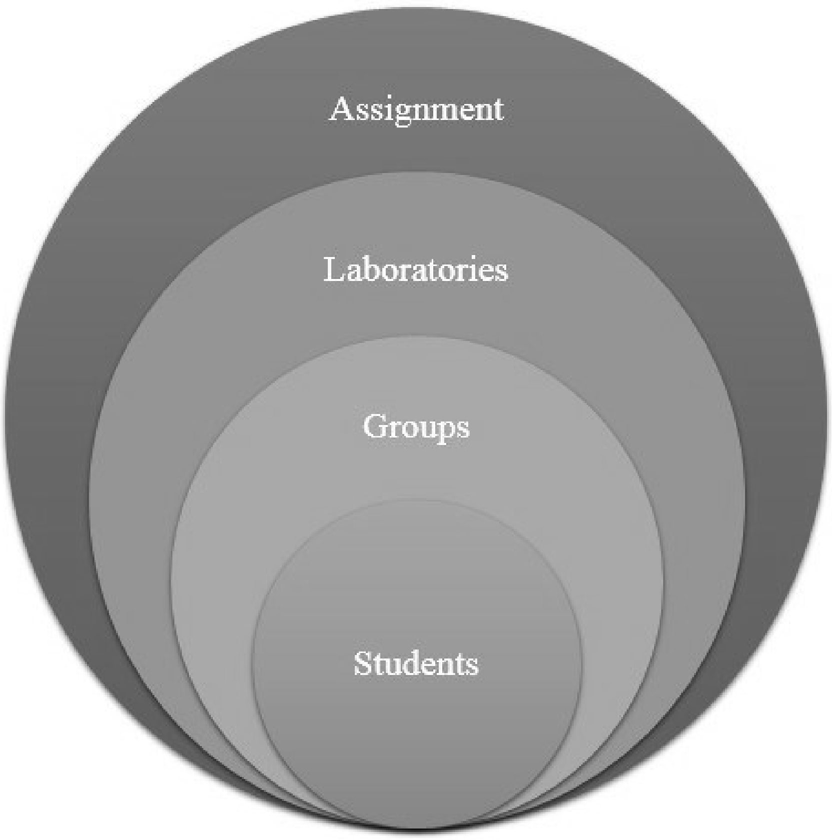

Figure 1. Assignment organization.

Laboratories were supposed to collect all the data from the groups of students that made measurements in the same conditions (same instruments and same objects). With all the gathered raw data, they were supposed to make basic measurement uncertainty calculations, including: expectancy, standard deviation and coverage interval. In addition to those basics, they were also instructed to remove from their calculations groups whose results failed to meet the so called Birge's ratio; commonly used in metrology for testing goodness-of-fit between the laboratories [1].

With all the data processed, laboratories made projector-backed presentations in which they presented calculated values both graphically and numerically. All of the laboratories and their corresponding groups were at the presentation. It was obligatory to present a conclusion to the presented data. After students shared their results with the audience and the professor, they were asked to explain any noticed irregularities.

Table 1. Assignments per laboratory.

Laboratory	Measuring instrument	Measured value
A	Vertical length measuring machine	Outer diameter of the steel ring
B	Toolmaker's microscope	Axial distance between two holes in a cast iron object
C	Vertical caliper	PVC pipe outer diameter
D	Micrometre	PVC pipe outer diameter
E	Coating thickness gauge	Coating thickness on a steel plate
F	Profilometer	Profile height (roughness) of grey cast iron plate

TECHNICAL ASPECTS

Students were supposed to be acquainted with basics of metrology because of the background they should have gotten in courses attended in previous semesters. There were students from different departments of the faculty but all of them had attended at least one metrology-oriented course. Handling instructions for all of the measuring instruments were briefly given by the professor so that the students could remind themselves how to correctly handle the instruments. Professor and assistant were also present in order to help out with any problems that might arise. Therefore, it has been concluded that the technical aspects were sufficiently covered.

However, during the evaluation it was noted that in about 30 % of all the groups, there was complete absence of elementary knowledge of metrology. Students were given comprehensive literature related to measurement uncertainty but still, it was noted that one laboratory and all of their corresponding groups were completely puzzled by the term and didn't understand it because their presented results had not been correct (Figure). Their box plot shows that groups 1, 3, and 4 had perfect measurements and almost non-existent uncertainty (indicated by the narrow band on the box plot). Such results could not be expected even from metrology professionals.

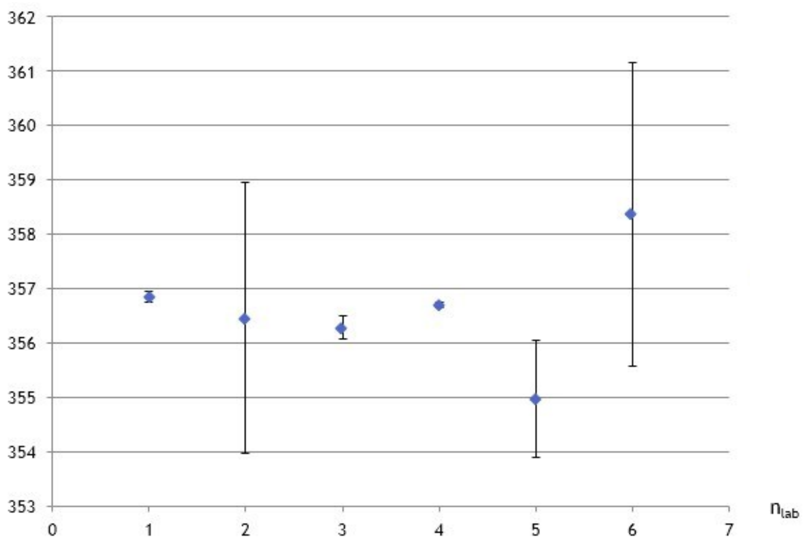

Figure 2. Poor understanding of measurement uncertainty resulting in a bad box plot.

In the case of one laboratory, the results themselves had not been written with respective units of measurement and the results had improper number of decimal places regarding to resolution of the instruments they used, Table 2. That was also noted within other groups that belonged to other laboratories (while the measurement process was being observed) but those mistakes were corrected in a manner that did not affect the results presented in the end.

Table 2. Part of the presentation showing the wrong number of decimal places and missing units of measurement.

Measurement result, D_{SP}	Measurement uncertainty, U
270,5	9,7
272,617	2,331
266,2	5,298
271,4	3,143
279,133	4,344
273,5	4,181

Previously mentioned Birge's ratio rule clearly states that when the ratio of a group of measurements exceeds value of 1, these results cannot be included in the comparison with other groups. It was observed that 50 % of the laboratories decided to ignore Birge's ratio and simply add uncomparable results to their charts.

Regarding the handling of the samples, students that used caliper and micrometre (two laboratories and their corresponding groups) showed unprofessional behaviour. Students either had not aligned the samples precisely, or they exerted too much force while they were measuring the samples using the micrometre; all of which resulted in measurements that were not accurate.

Thermometer was purposely integrated into the measurement as a clear indicator of attention and professionalism that students were supposed to show. Only 30 % of students actually used the thermometer to note the ambient temperature of the laboratory. Four out of six laboratories had to include the information about temperature in order for their measurements to be complete and accurate because of the thermal expansion coefficent. However, just 50 % of the laboratories measured temperature and expressed it as an important variable in their measurements. Laboratories that measured objects made from PVC noted the environment's and object's temperature, even though thermal expansion coefficient of PVC is much smaller than that of steel. Their colleagues, who had objects made from steel, surprisingly, were not worried about temperature and had not noted it. Clearly, that was unprofessional because as future engineers, these students are expected to pay attention to that sort of critical details which could one day be very costly.

All the laboratories considered, it was found that two laboratories obviously fabricated at least some of their results. On the day the presentations took place, it was impossible to hide irregularities because those were obvious when presented graphically (as shown in Figure). This pointed to fabrication and it exactly showed who had and who hadn't been ethical in their work. Presentations themselves demonstrated the amount of time and work each of the team invested in their efforts. It has to be noted that some of teams made excellent and truthful presentations that pointed to teams with good technical knowledge and ethical approach.

ETHICAL ASPECTS

Prior to further assessment whether students' behaviour should be considered ethical or unethical, common understanding of ethics and its relation to the engineering field is established.

According to Merriam-Webster dictionary [2], ethics can be defined as an area of study that deals with ideas about what is good and bad behaviour; a branch of philosophy dealing with what is morally right or wrong; a belief that something is very important. During their professional career engineers encounter various ethically doubtful situations. For example, engineers from the construction industry could find themselves under the duty whether to warn, when to warn, who to warn, and how to warn of any impending disasters [3, 4]. Furthermore, by extrapolating aforementioned example, we could state that engineers encounter following doubts:

- should I report unethical situation,
- when should I report unethical situation,
- to whom should I report unethical situation, and
- how should I report unethical situation?

During assessment of ethical, or unethical, practices and situations, one should take into consideration if included persons had freedom of choice [5]. Additionally, if we try to predict ethical behaviours of the system, one should consider the complexity, chaoticness, and level of discretion of analysed system [6].

Considering technical aspects presented in previous section, and the fact that most students acted similarly, we could state that student group conducted measurement exercise, statistical analysis and data presentation, in ethical manner. But, in order to get the whole picture, we should not look at the study group in isolation. It is safe to assume that study group is a part of larger community, i.e. faculty which includes other students, professors, assistants, administrative staff, etc. Furthermore, faculty is a part of even bigger community, in this case University of Zagreb, which includes numerous other faculties. We could continue to add various layers and communities, but for sake of simplicity, we will put society as all-encompassing layer (Fig. 3). Following aforesaid logic, we cannot assess students' behaviour as isolated community, and we have to take into consideration ethical practices of superimposed layers of community (e.g. The Code of Ethics of the Zagreb University, law, constitution).

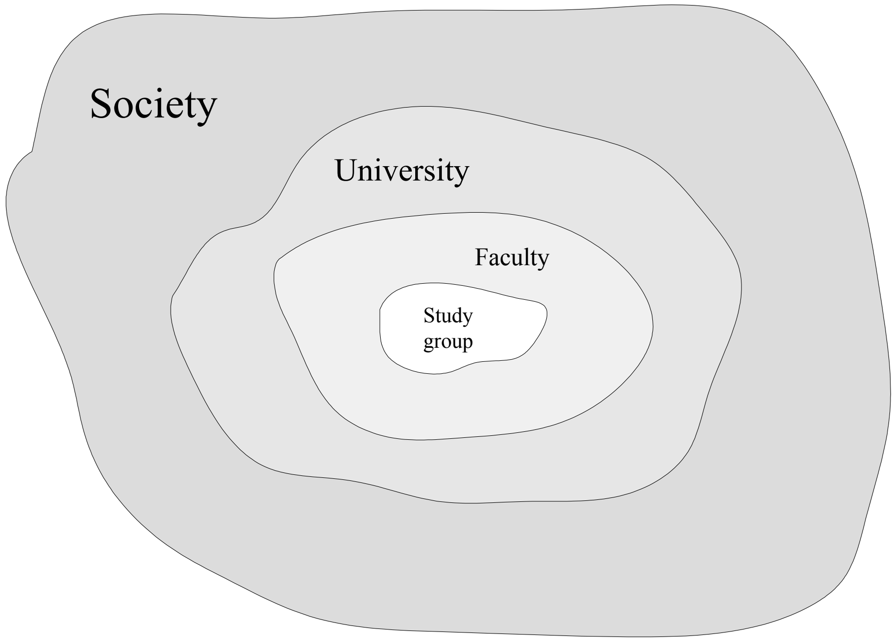

Figure 3. Study group and related communities.

CONCLUSION

This paper assessed ethicality of engineering students, by observing their behaviour and decision making process. Students were given the assignement to conduct various measurements using proper equipment, and perform appropriate data analysis. Later, they had to present their findigs, followed by presentation from pilot laboratories. Captured observations were divided into tehcnical, and ethical aspects.

Although the behaviour of the study group could be labelled as ethical, while assessed in isolation ("I did what I had to, and I did it just like everybody else."), we might not draw the same conclusion if we assessed the group from broader vantage point. Quite the contrary, there were elements that could be labelled as unethical, e.g. students' failure to conduct given tasks and exercises with due diligence, and several breaches of The Code of Ethics of the Zagreb University. Aforesaid findings do not necessarily imply further unethical decision making of invloved students, future professional engineers, but might rather show students' appathy regarding the assignement or the course itself.

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PROCJENA ETIČNOSTI STUDENATA

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SAŽETAK

U institucijama visokog obrazovanja etika je u temeljima onoga čime institucije nastoje moralno oblikovati studente. Tijekom nekoliko godina nakon studija ti će ljudi na svom radnom mjestu donositi odluke koje mogu utjecati na poslovanje i, što je još važnije, ljudske živote. Time ono što djeluje kao jednostavna sumnja u to što je ispravno a što nije, postaje izrazito važno. U razdoblju u kojemu profit utječe na mišljenje društva etika može biti zanemarena. Sveučilišta nastoje usaditi etičke principe, između ostaloga, pružanjem kolegija na odgovarajuću temu i samim ponašanjem nastavnika. Ovaj rad prikazuje jednu uvođenje novog kolegija, posvećenog etici, kao jedne primjene navedenih principa. Rad navodi neke potankosti kolegija, s naglaskom na ponašanju i odlukama studenata, uočenima tijekom provođenja postavljenih zadataka. Opažanja su podijeljena u tehnička i etička.

KLJUČNE RIJEČI

inženjerska etika, inženjersko obrazovanje, metrologija