Ethics Consideration Engineering as prevention of Engineering ethics education's being made ruin

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Abstract

The society admits the importance of the engineer ethics education in the higher education organization that teaches engineering. However, the following problem exists about the engineer ethics education. The teacher explains to the student, and the student understands and remembers the thing usually. However, it is dissatisfied only with it with the engineer ethics education. The student should notice the necessity of ethics besides understanding and the memory. This is very difficult. Because the student cannot develop creativity concerning ethics in the radical of the top-down education. Then, the author decided to propose the ethics creation education and ethics consideration engineering, and to attempt the solution of this problem.

The ethics creation education is an education method of the student's noticing the definition of engineering. Moreover, ethics consideration engineering is an engineering technique for uniting an ethical judgment to the application of engineering.

Keywords: Self-directedness, engineering ethics, ethics-based engineering, ethics-promoting education

1. Introduction

The enhancement of educational effects is a key issue in ethics education for engineers. To address this issue, the author and colleagues have been advocating a bottom-up approach which nurtures the ethical potential of students, along with the conventional top-down education. Verification of the bottom-up approach has been an important subject for the education policy of Ariake National College of Technology, aiming for students' self-enlightenment and creativity. Bottom-up education for engineering ethics involves 2 steps within the learning process for each engineering subject: 1) Students try to understand and become aware of the essence of engineering; and 2) teachers nurture students' ethical potential. While conventional micro-insertion and case methods are considered to be effective for step 2), this paper discusses practical approaches for step 1), using the term “ethics-promoting education”.

2. Proposal for ethics-promoting education and ethics-based engineering

2.1. Ethics-promoting education

According to the definition put forward by the committee on engineering education programs, engineering is “the art of applying scientific and mathematical principles, as well as knowledge of social and human sciences, to the creation of useful objects and a comfortable environment for the public, in terms of safety, health, and well-being”. In the author's experience, however, almost all students and a large number of teachers are not familiar with this definition.
A question arises here as to whether students must be taught the definition of engineering or relied on to learn it themselves.

A definition of engineering may focus on its purpose and essence, rather than practical applications such as the creation of productive value. Based on this interpretation, the definition should not be taught but be learned by students independently, and ethics-promoting education is education to raise their awareness of the definition.

2.2. Risk-based engineering and engineering ethics

According to the definition of engineering, efforts are also required to assess and reduce the risks of the application of engineering to production. Risk-based engineering, which has been suggested by Kobayashi et al. to base value judgments on risk, may be appropriate for this direction.

However, professional engineers must not only assess the risks, but also balance the contributions to the company (economics), welfare (convenience), and social responsibility (safety). This balance requires a standard base for judgments, independent of each value. Namely, the direction of engineering depends on the motives for applying it, and such motives are public safety, health, and well-being, as the definition describes. Engineering ethics is the very act of basing judgments on these motives. In other words, considering the fact that public safety, health, and well-being represent public requirements, engineering ethics may be regarded as aiming to listen to the public.

2.3 Ethics-based engineering

As mentioned above, human ethics as a base for the motives of applying engineering is indispensable for leading engineering in an appropriate direction. Therefore, it is necessary to assess and judge whether the direction of engineering is consistent with its definition in each process of the application of engineering to technical production (plan, specification, scheme, design, manufacturing, safety, disposal), in terms of engineering ethics. Such an engineering method to integrate the application of engineering with ethical judgments is called ethics-based engineering, contrasting with risk-based engineering.

As premises for the practice of ethics-based engineering, engineers are required to 1) direct themselves to 2) awareness of ethical issues and 3) technical production in accordance with the definition of engineering. To this end, continuing ethics-promoting education for students may be effective. It is also likely that ethics-based engineering and ethics-promoting education complement each other.

3. Ethics-promoting education for training in ethics-based engineering

3.1 Technique for ethics-promoting education

Among the above premises of ethics-based engineering, ethics-promoting education aims at 1) self-directedness and 2) awareness of ethical issues. For education addressing self-directedness and awareness, Montessori's bottom-up teaching method to bring out the potential of students is more effective than the top-down approach. To develop their potential, a challenge should be offered as an incentive. As previously reported, fieldwork training addressing safety issues is appropriate for education for 1) self-directedness, while 2) an awareness of ethical issues should arise from the naturally-developed ethical potential of students; therefore, an investigation on the development of the ethical potential is required, rather than education, at some point in the educational process.

3.2 Experiential safety training for self-directed learning

For education addressing 1) self-directness, we suggested hazard assessment by students as a fieldwork program, which demands high-level motivation.

The assessments were conducted by third-grade mechanical engineering students of Ariake National College of Technology in 5 sessions of 50 minutes each during special activity program 1, to identify hazardous conditions and areas on the college premises. Students were required to explain the reasons for their judgments.

3.3 Investigation of ethical potential development as a basis for ethical awareness

To investigate the development of the ethical potential in engineering students, an awareness survey was conducted among fourth- and fifth-grade students of all departments of Ariake National College of Technology
(mechanical engineering, electrical engineering, electronics and information engineering, architecture, chemical science and engineering) without preparatory education. The questionnaire contained 6 questions, with responses employing a 1-5 scale:

Q1: Do you know about the training of ethical engineers as our educational policy?
Q2: Do you affirm the necessity of ethics education for engineers?
Q3: How do you define ethical engineers?
Q4: What does society expect from products and services?
Q5: Is safety guaranteed as long as there are neither faults nor mistakes made by engineers?
Q6: What are the social contributions that students of this college can be proud of?

4. Summary of results

4.1 Experiential safety training

In general, students worked diligently. The majority of them regarded heavy doors, steps, and roadside drains in the nighttime as hazardous areas, and the lunchtime rush and driving scooters on the college premises as hazardous conditions. In respect of students’ motivation and self-directedness, primarily focused on in this study, the following results were obtained:

1) At least 10% of students were able to effectively consider others’ safety.
2) They showed a lack of knowledge of technical hazards such as those related to mechanical equipment, possibly due to limited hours of specialized training in these grades.
3) It seemed difficult for them to comprehend public requirements; their comprehension might motivate them to participate in safety training even in hot weather.

4.2 Survey results

Almost all students answered that they did not know about the training in question 1. In response to questions 2 to 4, while nearly 30% mentioned safety and security, several students pointed out that ethics is indispensable for safety. To question 5, a few answered that safety is not guaranteed unless consideration toward users is shown. To question 6, whose response rate was as low as 40%, some students answered that they were prepared to be professional (capable of addressing safety issues), and cope with both work and social contribution activities. These answers may be based on their experiences in the Support Program for Contemporary Educational Needs. In conclusion, development of the ethical potential was observed in fourth- and fifth-grade students to a certain extent, despite the limited hours of specialized programs.

5. Future issues

This study aimed to investigate whether ethics-promoting education is effective to enhance the effects of ethics education for engineers. Although the development of the ethical potential for consideration toward others and safety promotion was observed in students, it may be concluded that the results are insufficient to demonstrate the effectiveness of ethics-promoting education. However, these results also suggest the possibility of its bottom-up approach to develop an important basis for ethics education for engineers in the future. On the other hand, considering the contribution of environmental factors, such as specialized engineering training, to the educational effects, it is likely that such effects lessen after graduation. Therefore, ethics education for engineers in colleges of technology should be provided in the fourth- and fifth-grades to effectively enhance the educational effects.