

## ETHICAL ISSUES IN ENGINEERING EDUCATION CURRICULUM

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**ABSTRACT:** This study aims to reveal the ethical issues in engineering education curriculum in Iran. Basically, engineering education seems to be highly impacted by different factors in universities. In this study, the researchers tried to discover those ethical issues that affect the curriculum in engineering education. The Akker's curriculum components are examined in association with ethics. The data were collected through the interviews and semi-structured Delphi questionnaire. Analytic Hierarchy Process technique was applied to prioritize the curriculum components based on ethical concerns. The samples of the study were selected from those engineers that recently they were graduated from different Iranian universities. The results show that priorities of ethical issues, which were perceived by the students, are: assessment, teacher role, and learning activity, respectively.

**Keywords:** ethics, engineering education, curriculum

### INTRODUCTION

Ethics is defined as the study of morality and it is one of the concepts that is respected and praised in different communities. Ethics consists of a set of rights and wrongs, which are described by law, society, and traditions. It can be implied that ethics consists of some obligations, benefits, fairness, and some virtues. It is stated that ethics means the study of moral beliefs, and moral behaviors that can ensure the people and enterprises pursue reasonably well and satisfy moralities (Velasquez, 2015). Moreover, ethical codes based on some principles such as honesty, professional loyalty, and developments of professional competence fortify engineering education professionals with honor, integrity, and dignity. Social systems and enterprises can take advantage of fulfilling ethical privileges in order to introduce themselves well as prestigious and competent in local, national, and international levels. Therefore, ethics can be considered as the foundation of development for the engineering education.

Peters (2015) distinguishes that ethics as a part of philosophy that specifically argues and analyzes the answers to the practical questions about moralities. In contrast with theoretical discussions, in practical questions, the issue can be what the case is, and through the answers to these questions, the study defines the things to be settled and changed or modified. He states that to settle the educational issues it is necessarily needed to have an answer to the practical and theoretical questions. Whereas the education complies with the objectives of developing and improving, it requires some ethical values. He emphasizes that the matter and the manner of education strongly demand ethical bases.

In the challenging and growing decision-making situations in the engineering world, engineers need to rely on ethical decisions and consider morality issues as the concerns and determining matters. The fundamental ethical behavior of engineers can be built up during their academic study years and the road of morality can be paved from engineering education to engineering profession. In order to educate engineering students as to be properly prepared for their professional careers to overcome the challenges facing in developing engineering world of technology and services, engineering education needs to get improved reasonably, in accordance with the changes in relating medium of technologies, services, people expectations, and social welfare (Bhavya, 2009). In the current situation of information and communication, students expect some levels of curriculum style and educational attitude of the engineering education systems. Effectively, the contribution of engineers in changing paradigm of engineering proficiency, growing engineering technology markets, the evolvement of technological products, and increasing demanded a level of quality necessitate engineering graduates to have professional and ethical standards. Besides sufficient working abilities, which are demanded from engineering graduates, they need to have problem-solving skills and ethical decision-making capabilities.

Engineering education researchers pay special attention to curriculum improvement in order to respond the future of engineering education concerns and satisfy the growing demand for qualified and attitudinal engineers. They have come to study on instructional issues including the components of teamwork, timing and learning styles. It

is said that students' behavior and consequently, their professional behavior is influenced by learning (Lawrence, 2007). For the revision and redesigning of educational systems, researchers employ psychological, sociological, communicational and other behavioral models (Svinicki, 2008). Actually, a basic model of learning framework 'How People Learn (HLP)' model is explained by Svinicki (2008). In this model, there are four well-known thrusts, which are mostly used as instructional design theories and consist of student-centered, knowledge-centered, assessment-centered, and community-centered instructions. This research aims to examine the development of the efficient education through investigating ethical concerns in the engineering curriculum.

To design the structure of the study in data gathering about ethical issues, which are observed by engineering students, researchers needed to find out, which questions could be the best suitable items to consider engineering education curriculum. Whereas the outcomes of this study and the similar works can be used for the purpose of curriculum improvement, the curriculum definitions and consisting factors should be considered effectively. It is mentioned that in curriculum improvement, different factors and components are needed to be in balance and there is some sort of components, which are defined by professionals of curriculum. One of the classified curriculum definitions is given by Walker which comprises three main parts in the curriculum as purpose, content, and organization of learning (Akker,2010). To have a more appropriate-detailed association of curriculum components and factors, later studies have progressed leading to a complete design, which is introduced by Akker (2010). He provides ten items in his elaborated curriculum design. These components are listed in Table 1. In this article, Akker's curriculum components are used as the cornerstone to examine the engineering education curriculum as to provide a classified question to enable the authors evaluating ethical concerns faced by engineering students during their educational years. It is said, there is an interest in engineering education research to work on aims and objectives of engineering education curriculum in the matter of content and organization of assessment and evaluation (Bhavya,2009).

Table 1. Akker's Curriculum Components

Rationale or Vision*	Why are they learning?
Aims and Objectives	Toward which goals are they learning?
Content	What is learning
Learning activities	How are they learning?
Teacher role	How is the teacher facilitating learning?
Materials & Resources	With what are they learning?
Grouping	With whom are they learning?
Location	Where are they learning?
Time	When are they learning
Assessment	How to measure how far learning has progressed

\*: The rationale or vision is considered as the core of this classification of components and each of other components provides an aspect of the curriculum rationale (Akker, 2010).

Engineering education research can be a 'translational' study, which connects the engineering practices to knowledge (Bhavya, 2009) and feedbacks if it is attentive to applied interaction of science and practice. Several educational researches are conducted based on teachers' viewpoints (Svinicki, 2008). This study is based on students' observation and assessment. On the student-centered instructions, researchers survey the attitudes, needs, and judgment of current/ ex-students. In the assessment-centered research the frequent and informative statements, and feedbacks are evaluated (Svinicki,2008). In this study, assessment is based on views and experiences of the engineering education, a community of engineers, working in electric power utility service company in Iran (HEDC). Results and findings of the study based on the field study can help the engineering education to get improved by considering the current educational systems' weak points and going through the issues, which are needed to be redefined and re-established with deploying the kind of educational services covering the most appropriate ethical codes. Designing educational systems with a higher level of moralities and defining an effective ethical code in engineering education curriculum can provide and improve the system's professional competence, prestige, and efficiency.

## METHOD

In engineering education research, there is no specific advantage for any of qualitative, quantitative, or mixed mode method (Johri, 2011). This study is conducted using the qualitative-quantitative, mixed-method. While the respondent opinions are surveyed and interviewed based on their descriptive statements, the frequency of the

similar concepts explained by participants is considered to determine the main concerns in each curriculum component of engineering education. On the other hand, prioritizing the components is done using analytic hierarchy process (AHP). AHP is one of the multiple criteria methods that are used in decision makings where there are several alternatives and criteria. The consistency analysis of the rated priorities determines whether the preference ratings are consistent (Geoff, 2004).

Delphi semi-structured questionnaire is provided and includes ten explicit questions about ethical concerns observed and experienced by the study participants. The field of the study is an Electric Power Utility company of Iran (HEDC). The respondents are 27 engineers aged between 28 to 45 years old, almost 90 percent of participants are electrical engineers and most of the senior engineers have participated in engineering higher education during four recent years. The respondents' observations and experiences cover their degree study years which go to past 5 to 20 years and their postgraduate study which is pursued recent 4 years- this is because of the recent availability of postgraduate courses in the regional universities. Meanwhile based on the personnel combination of HEDC, almost 80 percent of the respondents are male engineers. The participants have studied their engineering majors in different national universities.

### RESULTS AND FINDINGS

Using Akker's curriculum components, ten questions are defined to find out about the main ethical issues in engineering education from the perspective of engineering students. Respondents, professional engineers, have stated their opinions based on their experiences of whatever they think that has been an important issue during their study years. Totally 103 ethical issues are listed in 10 components of the curriculum, which after modification reduced to 91 concerns. Among different components the maximum number of ethical issues is illustrated in 'assessment' item, which is 18 ethical concerns and the least concerns is in 'location' item of curriculum with 6 concerns. After the assessment component, 'lecturers' role', and 'grouping' include higher concerns. In the whole curriculum components, the main ethical issue which more frequently is stated by participants is listed in Table 2. For the two highest ethically concerned components of assessment and lecturers' role, the most important stated ethical issues are "theoretical assessment" and "not properly guiding students" respectively.

Table 2. The Curriculum Based Questions and the Highest Frequent Concerns

Question	The highest frequent given answer
What are the main ethical issues related to the content of engineering education curriculum	The lessons are taught theoretically
What are the main ethical issues related to learning activities?	The subjects are taught theoretically that are not practical
What are the main ethical issues related to the lecturers' role?	Students are not appropriately guided by lecturers in the projects and dissertations
What are the main ethical issues related to material and resources?	The fixed subjects are not offered each semester
What are the main ethical issues related to grouping?	Plagiarism in doing assignments and projects
What are the main ethical concerns related to the location?	Inappropriate atmosphere in the classrooms
What are the main ethical issues related to time component?	Schedules are not properly planned based on the students' needs
What are the main ethical issues related to assessment?	Examinations are focusing on theoretical aspects of learning rather than practical
What are the main ethical issues in aims and objectives of engineering education curriculum? *	Lack of job opportunities
What are the main ethical issues related to rationale or vision of engineering education curriculum? *	Decreasing status of education because of the market problem

\*: The concerns about aims and the rationale or vision seem not to be ethical concern but the respondents judge that when normally in this society engineering education is believed as a desired field of study and is praised as remarkable success for the academic study applicant, practically facing lack of job opportunities for graduates is not fair and they think that this conflict is an ethical concern.

In the next step, to find out which components have the priority regarding ethical issues, the curriculum components are examined using AHP method. The examination is done by two representatives from the two main groups of participants, electrical, and non-electrical engineers using a primary questionnaire. For each component, the pair wise comparison matrix is developed and then it is normalized and followed by weighting for the components. Finally, consistency analysis is evaluated (Bunruamkaew, 2012). The questionnaire design of the first step of AHP is presented in Table 3 (Appendix); one part of a whole pair-wise comparison matrix is shown in Table 4 (Appendix); Table 5 (Appendix) presents the normalization of comparison matrix. Using consistency index in AHP computational model of CI which is calculated 0.31 and random index of the comparison between 10 variables, RI, which is 1.49 (Geoff, 2004), Consistency Ratio (CR) is calculated 0.21. Although the consistency ratio of blew the limit of 0.1 shows the judgments in comparison of the factors are reasonably consistent; however, Geoff (2004) states that CRs higher than 0.1 sometimes have to be accepted. He emphasizes that excess of 0.1 shouldn't be too much as he clarifies that CR =0.9 means the judgments are completely untrustworthy.

Figure1 shows the judged ratings of curriculum components regarding ethical issues. Most ethically concerned components of the engineering education curriculum are Assessment, Lecturer role, and learning activities. It seems that the importance of assessment and lecturer role is well-known and established as they exist in the list of 14 items in the code of ethics of American Society for Engineering Education, as fair evaluation and treating fairly (ASEE, 2012). Figures 2 and 3 present the details of ethical issues stated by the participants for assessment and lecturer role, respectively.

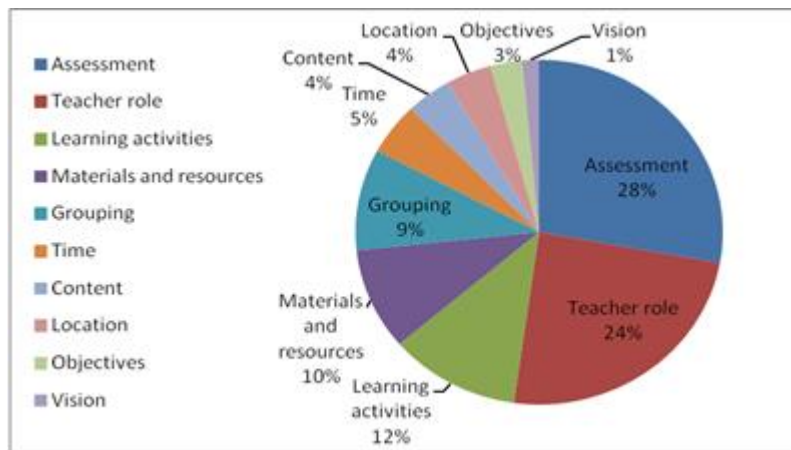


Figure 1. Priority Ratings of Ethically Involvement of Akker's Curriculum Components

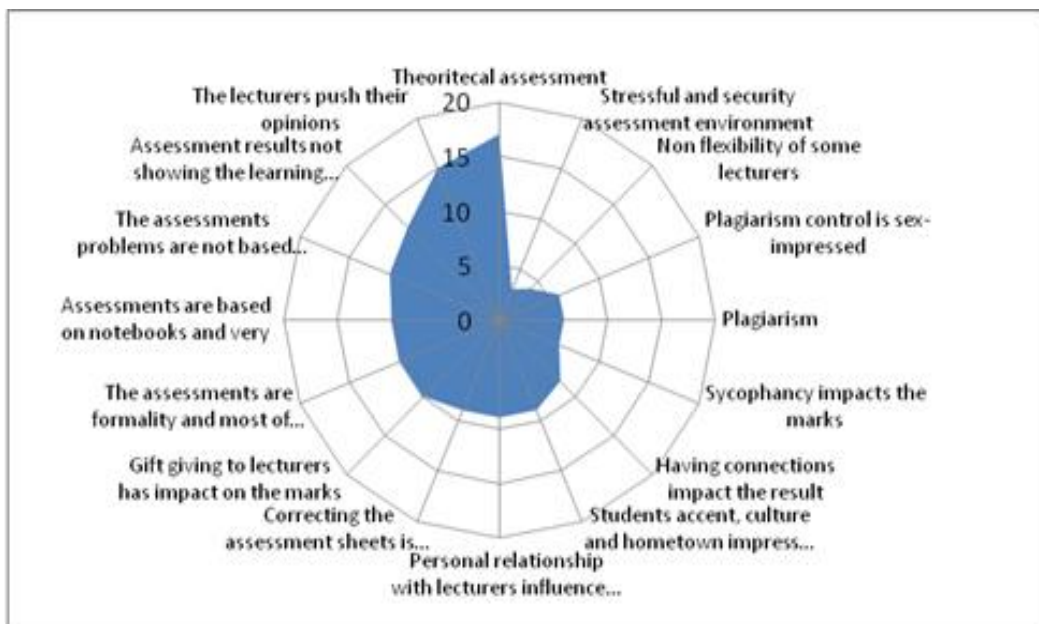


Figure 2. Main Ethical Issues Related to Assessment in Engineering Education Curriculum

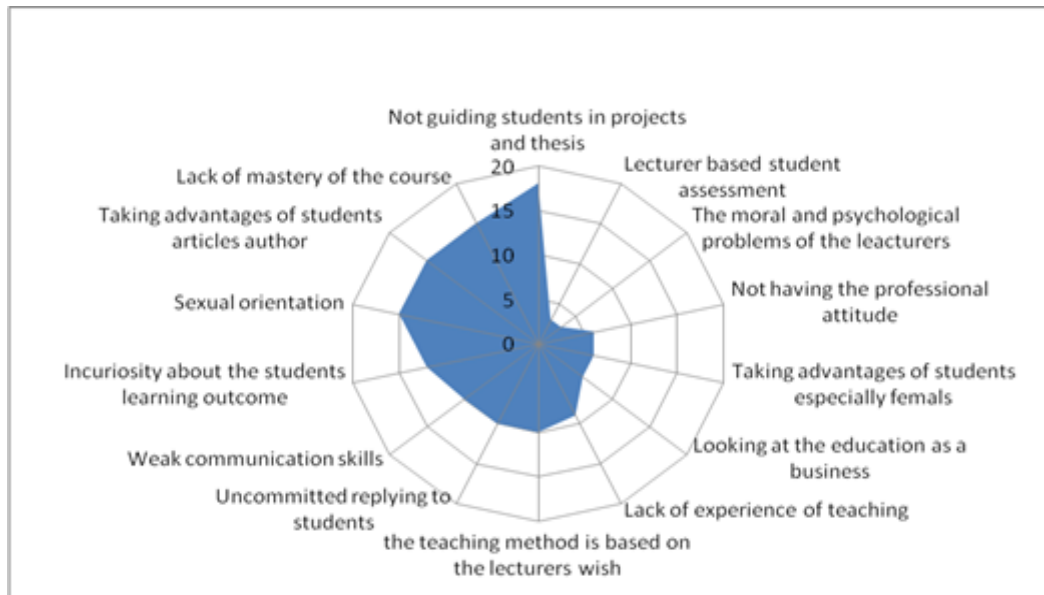


Figure 3. Main Ethical Issues Related to Lecturers' Role in Engineering Education Curriculum

In the ethical concerns, some issues are stated in more than one component such as gender orientation, which is considered as one of the issues both in lecturer's role and assessment. These kinds of duplicated concerns are taken into consideration and are counted while some statements, which give the same concept in different explanations, are modified to a central phrase. The listed ethical issues, which are surveyed, include some concerns that do not fit in curriculum component categories. Some of these concerns are religious autarchy and inconsiderate curriculum scheduling in the matter of the students, welfare, and requests.

### CONCLUSION

Engineering education systems need to be monitored and evaluated precisely from different perspectives to meet the growing expectations of engineering world and humanities. One of these aspects is ethical issues, which is investigated in this article. The student-centered evaluation is conducted specifically on the aspect of ethical concerns. The study framework is based on Akker's curriculum components. Research-based findings can be employed to guide the individual actions, establish efficient ethical codes, and revise education system actions. This article clarifies that assessment, lecturer role, and learning activities are the three top curriculum components, which involve highest priorities in students' ethical concerns. The most important ethical issues stated in these components are "theoretical assessment" and "not properly guiding students".

### RECOMMENDATIONS

Further study is recommended to survey the ethical concerns of engineering education curriculum from the students' viewpoint in different regions, which can lead to define curriculum standardized ethical codes. However, the authors are supposed to redesign this study to improve the current consistency ratio of 0.2 in AHP technique to less than 0.1.

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