

## **What Should be Taught in Engineering Ethics Education Under Globalization?: Based on the Comparative Analysis of University Textbooks in China and the United States**

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# What Should be Taught in Engineering Ethics Education under Globalization? --Based on the Comparative Analysis of University Textbooks in China and the United States

## Abstract:

As an emerging subject, engineering ethics plays an important role in guiding, standardizing and exploiting engineering activities/construction. Prior research shows that engineering ethics generated in each country with diverse backgrounds, and engineering ethics education was also conducted with its own diverse characteristics. However, with the growing multinational cooperation in engineering, the international mobility of engineering students and engineers, and climate change and ecological challenges, engineering ethics has become a global issue. Faced with international engineering ethics problems, taking a global perspective in engineering ethics education will help ensure that engineers can make a more substantial contribution to the development throughout the world.

What should be taught to the future engineers to meet the need of global engineering ethics is the first-line question for universities to answer. As the embodiment of courses standards and syllabi, textbooks are important links between courses design and implementation. They are the materialized results of previous courses research, as well as the necessary tools for the later stage of courses implementation. As the carrier of teaching contents, engineering ethics textbooks are the important source of information that teachers and students can rely on in the engineering ethics teaching. Therefore, this paper presents research on the educational contents of engineering ethics under globalization by comparative analyses of university textbooks in China and the United States. The textbooks selected for this study include three American textbooks- *Engineering Ethics: Concepts and Cases* (Charles E. Harris, Michael S. Pritchard, Michael J. Rabins), *Engineering Ethics* (Charles B. Fleddermann), *Ethics in Engineering* (Mike W. Martin, Roland Schinzinger), and three Chinese textbooks- *Engineering Ethics*(Yongqiang Zhang), *Engineering Ethics*(Song Zhang), *Engineering Ethics*(Zhengfeng Li, Hangqing Cong, Qian Wang, etc.). All of them are classic and commonly used. Methodologies including keywords extraction, text analysis and comparative research are used to compare the six textbooks from the dimensions of style, frame, topics and cases.

By the comparative study of two of the world's leading countries in engineering education, the similarities, differences and features of engineering ethics educational contents in both countries are revealed. The generalities reflect the common foci of engineering ethics education. Engineering ethics textbooks set forth the basic concepts, theories and principles of engineering ethics firstly; then according to the special requirements of engineering profession, put forward some issues such as the responsibilities of engineers, stakeholders in engineering, and how to practice ethical norms in science and technology activities and engineering practice; and finally probe the practical problems such as ecological responsibilities of the engineers. These generic and common knowledge are consistent with the goal of engineering ethics education. Findings of the comparison also identify lessons worth learning from each other. Based on the analysis results and the need for globalization, the paper attempts to highlight several key points of engineering ethics educational contents. Due to limited space, the findings which are expected to be helpful to the engineering teachers and students in engineering ethics education are still preliminary. Therefore, further

study on engineering ethics textbooks would be conducted to find more similarities and differences in order to better explore the educational contents of engineering ethics education under globalization.

**Keywords:** engineering ethics, educational contents, textbooks, text analysis, keywords extraction, comparative study

## Introduction

Engineering Ethics came into American universities as a subject in the late 1970s, and was widely set up in engineering colleges in different forms [1]. Chinese scholars and teachers began to pay attention to it in the late 1990s [2]. As an emerging subject, engineering ethics plays an important role in guiding, standardizing and exploiting engineering activities/construction. Prior research shows that engineering ethics generated in each country with diverse backgrounds, and engineering ethics education was also conducted with its own diverse characteristics. However, with the growing multinational cooperation in engineering, the international mobility of engineering students and engineers, and climate change and ecological challenges, engineering ethics has become a global issue. Faced with international engineering ethics problems, taking a global perspective in engineering ethics education will help ensure that engineers can make a more substantial contribution to development throughout the world.

Engineering ethics consciousness is not inherent to engineers, but is gradually cultivated through systematic learning and practice [3]. As Norman R. Augustine [4] proposed, “Most of the engineers get into trouble on ethical matters did so not because they were not decent people but because they failed to recognize that they were confronting an ethical issue. As a result, they made horrendously bad decisions”. As the cradle of developing future engineers, Engineering College in universities plays an irreplaceable role in the education of engineering ethics. Michael Davis [5], an American engineering ethicist, has also summed up the objectives of engineering ethics education in universities as follows: improving students’ moral sensitivity, increasing students’ understanding of the standards of professional behavior, improving students’ ethical judgment, and enhancing students’ ethical willpower [3]. Zhengfeng Li et al. [3] further summarized it as: cultivating the sense and responsibility of engineering ethics, mastering the basic norms of engineering ethics, and improving the decision-making ability of engineering ethics. Then, to answer this question, “What should be taught to the future engineers to meet the need of global engineering ethics”, we must firstly understand the situation of international engineering ethics education at present, namely understanding the contents of engineering ethics education in various countries under the background of globalization. Due to the limitation of research space, this paper takes China and the United States, two of the world’s leading countries in engineering education, as the research objects. As the carrier of teaching contents and subject knowledge, textbooks, which contain the “ideal contents” [6] of curriculum, are primary information sources that teachers and students can rely on in the instruction of engineering ethics. Furthermore, it is through the textbook that official knowledge is most readily made available to students [7], [8]. Therefore, this paper mainly presents research on the educational contents of engineering ethics under globalization by comparative analyses of university textbooks in China and the United States. It is necessary to note that this article does not simply regard a textbook as a course, and a textbook is not the whole of the course. However, the textbook, as the materialization of curriculum standard and the learning outcomes in the syllabus, is an

important link between curriculum design and curriculum implementation. It is also a materialized result of previous curriculum research, and the essential tool for the later stage of course implementation [9]. By choosing textbooks, teachers and students, to a large extent, choose the contents of teaching and learning.

There is extensive research on the analysis and comparison of textbooks, including the analysis of the content and theme of the textbook of one subject [10], analysis of the characteristics of textbooks [11], comparison of the new and the old textbooks [12], international comparison on textbooks of one subject [13], [14], [15], cross-country comparison of the textbooks on one topic [16]. These researches provide a good reference for this article on analytical framework, analysis methods and research design. According to the contents of engineering ethics textbooks, combined with the research objectives, this paper mainly analyzes the themes, contents, cases and format of engineering ethics textbooks in China and America.

## Methodology

Through reading the related works of engineering ethics, combing the engineering ethics literatures and references, it is found that the works commonly cited by the researchers of engineering ethics including [17]: *Ethics in Engineering*(Mike W. Martin, Roland Schinzinger), *Engineering and Ethics*(Baum), *Engineering Ethics: Concepts and Cases*(Charles E. Harris, etc.), *Ethics in Engineering Practice and Research*(Whitbeck), *Engineering Ethics*(Charles B. Fleddermann), *Ethical Issues in Engineering*(Johnson), *Engineering, Ethics and the Environment*(P. Aarne Vesilind, Alastair S. Gunn), *Thinking like an Engineer*(Michael Davis), *Engineering Ethics*(W. Richard Bowen), *Engineering Ethics*(Zhengfeng Li, etc.), *Engineering Ethics*(Song Zhang), *Engineering Ethics*(Yongqiang Zhang), *Engineering Ethics*(Li Jin), *Introduction to Engineering Ethics*(Ping Xiao), *Engineering Ethics*(Li Liu), and so on. Several classic English books have also been translated into Chinese, Japanese and Indonesian, etc. According to the orientation of these books and research needs, three American textbooks and three Chinese textbooks are selected for research. As shown in Table 1, the American textbooks include: *Engineering Ethics: Concepts and Cases* (Charles E. Harris, Michael S. Pritchard, Michael J. Rabins), *Engineering Ethics* (Charles B. Fleddermann), *Ethics in Engineering* (Mike W. Martin, Roland Schinzinger), and three Chinese textbooks include: *Engineering Ethics*(Yongqiang Zhang), *Engineering Ethics*(Song Zhang), *Engineering Ethics*(Zhengfeng Li, Hangqing Cong, Qian Wang, etc.) All of them are classic and commonly used. In addition, the three Chinese textbooks are marked as classic textbook or “Nationally Planned Textbook” on their covers. The three selected American textbooks with more than 3 editions have been translated into Chinese and other foreign languages. The common use and wide spread also reflect the globalization to some extent.

Because of the different format of each textbooks, the quantity and form of each textbook contents are different. The contents have first, second and third level headings in some textbooks, and have only first and second level headings in other textbooks. Regarding the expression of the headings in the contents, some headings appear as questions, so that the content may be ambiguous. There are also one-word headings and some are indicated as short sentences. Moreover, some headings do not communicate the content of the chapter effectively, e.g., “do the right thing” or “learn from the past”. In order to address these discrepancies or inconsistencies between the form and the content of the textbooks, this paper firstly recombines the text information of contents by the method of keywords extraction. In

the process of headings recombination, firstly, English-language textbooks and Chinese-language translations of the English textbooks are matched, compared and amended for the greatest degree of assurance of the equivalency of topics. Then the emendation contents of the English Textbooks are compared with Chinese textbooks. Finally, the contents headings of each textbook are rearranged by dividing into new first level titles and new second level titles. Under the unified form of expression and presentation, the contents of each textbook are compared and analyzed.

Table 1. Introduction of the Six Selected Textbooks

No	Titles	Authors and Translators	Edition	Press
TB1	Engineering Ethics	Charles B. Fleddermann	4 <sup>th</sup>	Prentice Hall
	Translation in Chinese	Yicen Zhang, Yuxing Lin, compile	4 <sup>th</sup>	Taiwan Pearson Education Publishing co. LTD.
TB2	Engineering Ethics: Concepts & Cases	Charles E. Harris Michael S. Pritchard Michael J. Rabins	3 <sup>th</sup>	Wadsworth, Cengage Learning
	Translation in Chinese	Hangqing Cong, Qi Shen, etc., translate	2006	Beijing Institute of Technology Press
TB3	Ethics in Engineering	Mike W. Martin Roland Schinzinger	4 <sup>th</sup>	The McGraw-Hill Companies, Inc.
	Translation in Chinese	Shixin Li translate	2010	Capital Normal University Press
TB4	Engineering Ethics	Yongqiang Zhang	2011	Beijing Institute of Technology Press
TB5	Engineering Ethics	Song Zhang	2015	Dalian University of Technology Press
TB6	Engineering Ethics	Zhengfeng Li, Hangqing Cong, Qian Wang, etc.	2016	Tsinghua University Press

## Results and Discussions

### *Overall Comparison of Textbook Contents*

Since the number of Chinese and English words is not comparable, the Chinese versions of the three American textbooks are compared with the three Chinese textbooks in the perspective of their overall contents. The paper size of the textbooks is basically the same. And in terms of the number of pages, there are 271 pages of TB1, 310 pages of TB2, 388 pages of TB3, 238 pages of TB4, 151 pages of TB5, and 329 pages of TB6. As for the number of chapters, the chapters of the textbooks from TB1 to TB6 are respectively 8 chapters, 11 chapters, 10 chapters, 8 chapters, 8 chapters and 12 chapters. In general, the total number of chapters is bigger and the number of pages is relatively larger. The specific contents and the number of knowledge points will be presented in the following passages through the statistics of the primary and secondary headings.

Table 2. The Quantity of Pages and Chapters of the Six Textbooks

	<b>TB1</b>	<b>TB2</b>	<b>TB3</b>	<b>TB4</b>	<b>TB5</b>	<b>TB6</b>
Pages	271	310	388	238	151	329
Chapters	8	11	10	8	8	12

The contents of the six textbooks basically include chapter title, the outline of the chapter or the conclusion of the chapter, examination questions or discussion questions, reference cases or case analysis, and references. The most directly perceived difference in the contents of the textbooks between China and the United States is that the appendices of the textbooks in the United States show the ethical code of the professional engineering association, which illustrates the importance that the United States attaches to the ethical norms of engineers. Moreover, TB1 presents the ethical code for professional engineering association outside the United States, with special chapters on how non-Western societies like China, India and the Middle East view the ethical issues; In TB2, there is an exclusive chapter on professional standards and norms that above the culture of the international engineering; In TB3, there is a special chapter on global issues, including subsections like transnational corporations, computer ethics and the internet, and arms development; TB4 and TB5 also have chapters on the responsibilities of engineers in the international environment. These texts are the embodiment of the internationalization of engineering ethics. While on the other hand, it also reflects that the current international education of engineering ethics has begun to attach importance to the problems of internationalization.

### *Comparative Analysis of the First Level Titles*

Through the method of keyword extraction, the textbook contents are reorganized, and keywords or key phrases of 22 new first-class headings are obtained without changing the expression of chapter titles in the original contents of the textbooks as far as possible. As shown in Table 3, “Y” represents the keywords of the first-class titles in the textbooks, and a blank space indicates that this keyword is not covered in the textbook contents. The contents of each textbook are matched one-to-one with the keywords of the new first-class titles, and are arranged in descending order according to the number of times that the keywords appear. It can be seen from Table 3 that “introduction”, “risk, safety, accident, law” and “the practice and application of ethics” are included in all textbooks contents. Phrases like “ethical codes, ethical norms” and “the rights and responsibilities of engineers” appear five times, and “honesty, integrity and morality” appear four times. “Moral frame”, “stakeholders”, “engineer professional ethics”, “responsibilities” and “ethical issues in engineering practice” appear three times respectively. It shows that the contents represented by these keywords are the common concerns in the teaching of engineering ethics education. “Moral reasoning”, “literature review”, “engineering is a social experiment”, “value, interest”, “justice”, “professionalism”, “skills at solving ethical problems”, “the development of European and American philosophy”, “domestic engineering ethics education” and “engineers and technological progress” appear one time and only appear in some textbook. To a certain extent, the textbooks of engineering ethics education discuss engineering ethics theories and the common problems in the engineering practice, and at the same time, differently present the special problems in different countries and different fields. The textbook have their own focus in terms of these special problems, which reflects the differences and characteristics of the textbooks.

Table 3. Statistics of the First Level Titles

The First Level Titles	TB1	TB2	TB3	TB4	TB5	TB6
introduction	Y	Y	Y	Y	Y	Y
risk, safety, accident, law	Y	Y	Y	Y	Y	Y
the practice and application of ethics	Y	Y	Y	Y	Y	Y
ethical codes, ethical norms	Y	Y	Y	Y		Y
the rights and responsibilities of engineers	Y	Y	Y	Y	Y	
honesty, integrity and morality		Y	Y	Y	Y	
moral frame		Y	Y		Y	
stakeholders				Y	Y	Y
engineer professional ethics		Y		Y		Y
responsibilities		Y	Y			Y
ethical issues in engineering practice	Y				Y	Y
international engineering ethics/global issues		Y	Y			
moral reasoning			Y			
literature review				Y		
engineering is a social experiment			Y			
value, interest						Y
justice						Y
professionalism	Y					
skills at solving ethical problems	Y					
the development of European and American philosophy					Y	
domestic engineering ethics education					Y	
engineers and technological progress			Y			

22 key phrases are extracted from the first headings. Because of the compilation and expression differences among different textbooks, these keywords are general so that all of the contents of the textbook can not be completely represented. Therefore, what follows in the ensuing paragraphs is further excavation and analysis of the secondary and tertiary headings in the textbooks.

### *Comparative Analysis of the Second Level Titles*

TB3, TB4, TB5 and TB6 all contain the first, second and third class titles. TB1 and TB2 consist of the first and second-class headings. Especially the second class titles of TB1 are very succinct, with very few words and relatively less information. Therefore, through the reorganization of directory information and the combination of the specific contents in each chapter of the textbooks, the keywords of new subtitles are extracted (see Table 4). Since many of the key phrases in Table 3 appear only in some textbook, this paper only has an elaboration on the first class titles, which appear more frequently. First of all, by comparing the serial numbers of the textbooks in the first column and the third column of Table 4, it is

found that the serial numbers of the first column are all included in the third column, which demonstrates the effectiveness of the first-class titles extraction to a degree. Besides, very few numbers of the third column do not appear in the first column, indicating that some of the knowledge points are not covered by the first class titles, thus further explaining the necessity to extract the secondary titles.

Table 4. Statistical Analysis of the Second Level Titles in the Textbooks

The First Level Titles	The second Level Titles	Textbooks
introduction (TB1-TB6)	engineering	TB1, TB3, TB4, TB5, TB6
	engineering ethics	TB1, TB4, TB5
	ethical thought	TB1
	ethics and law	TB1
	profession	TB2, TB3
	engineering ethics and its significance	TB1, TB3, TB4, TB5
	engineers	TB4
	ethic and ethics	TB4, TB6
risk, safety, accident, law (TB1-TB6)	safety and risk	TB1, TB2, TB3, TB5, TB6
	accident	TB1
	assess and mitigate risks	TB2, TB3, TB5, TB6
	definition and method of acceptable risk	TB2, TB3
	engineer's legal liability for risk	TB2,
	risk and avoidance	TB4
the practice and application of ethics (TB1-TB6)	environmental/ecological ethics	TB1, TB2, TB3, TB4, TB5, TB6
	computer ethics	TB1, TB2
	gene engineering ethics	TB4
	information engineering ethics	TB4
	civil engineering ethics	TB4, TB6
	(hydraulic engineering/ chemical engineering/ nuclear engineering/ information and big data engineering/ biomedical engineering) ethics	TB6
ethical codes, ethical norms (TB1-TB4, TB6)	codes of engineering ethics	TB1, TB3, TB4
	professional ethical norms of engineers	TB2, TB4, TB6
the rights and responsibilities of engineers (TB1-TB5)	professional responsibilities	TB1
	employee	TB2, TB3
	loyalty	TB2, TB3, TB4, TB5
	professional rights	TB1, TB3
	disclose	TB3, TB4, TB5
	professional ethics	TB4
	engineer's responsibility in the international environment	TB4, TB5
honesty, integrity and morality (TB2-TB5)	honesty and dishonesty	TB2, TB3, TB5
	intellectual property	TB2
	keep secret	TB2, TB3
	inform the public	TB2
	conflict of interest	TB2, TB3
	humanitarianism	TB4
	integrity and morality	TB4



moral frame (TB2, TB3, TB5)	public morality	TB2
	moral justification	TB2
	utilitarianism	TB2, TB3, TB5
	respect people	TB2
	rights ethics and duty ethics	TB3, TB5
	virtue ethics	TB3, TB5
stakeholders (TB4-TB6)	contract theory	TB4
	stakeholder theory	TB4
	engineering and stakeholders	TB4, TB5, TB6
	gambling of engineering stakeholders	TB4
	justice	TB6
engineer professional ethics (TB2, TB4, TB6)	professional ethical norms of engineers	TB2, TB4, TB6
	professional engineering society	TB2
responsibility (TB2, TB3, TB6)	obligations - responsibility and reasonable care	TB2
	kindness	TB2
	virtue	TB2
	fault - liability and causes	TB2
	responsibility	TB3, TB6
ethical issues in engineering practice (TB1, TB5, TB6)	ethical issues	TB1
	ethical issues in engineering activities	TB5
	the characteristics and solutions of ethical issues in engineering practice	TB6
international engineering ethics/global issues (TB2, TB3)	international engineering standards	TB2
	super-cultural norms	TB2
	bribery, extort bribes, gift	TB1, TB2
	transnational corporation	TB3
	computer ethics and Internet	TB3
	weapons development	TB3

It can be seen from Table 4 that the textbooks of engineering ethics between China and the United States mainly have discussions on the basic concepts and theories of engineering ethics and the common problems arising in the course of engineering practice. As for the practice, all the textbooks are concerned about the contents of the environmental or ecological ethics, which is in accordance with the requirements of global ecological and environmental problems in the current course of development. In addition, TB6 also focuses on the ethics of civil engineering, hydraulic engineering, chemical engineering, nuclear engineering, information and big data engineering, and biomedical engineering. These special ethical problems encountered in different engineering practices are analyzed pertinently. In particular, the contents of information and big data ethics caters to the needs of big data era. Therefore, the textbooks of engineering ethics and the contents of engineering ethics education should also keep pace with the times and be updated constantly.

### *Analysis of the Characteristics of Cases in the Textbooks*

The goal of engineering ethics education is to cultivate the consciousness of engineering ethics and sense of responsibility, to make students master the basic norms of engineering theories, and to improve the decision-making ability in engineering ethics. The practical

characteristic of engineering determines that the goal of engineering ethics education is realized in teaching and tested in engineering practice. In other words, the real value of engineering ethics should be reflected through the practical effectiveness of engineering ethics [18]. Therefore, case teaching has been a prominent feature of engineering ethics education. A large number of cases are arranged in the textbooks, some of them are real cases, and some are fictitious by the authors according to the needs of teaching and research. Viewed formally, these cases mainly include cited examples, text cases, post-chapter cases. Cited examples are at the beginning of the chapter, in order to elicit the contents of this chapter and stimulate students' interest in learning. Text case in this paper is the case corresponding to the theoretical analysis in the chapter, which makes the knowledge points be understood more easily. The case study after the chapter enables students to use the theory described in this chapter to analyze the practical problems and consolidate the learning results. It can be seen that case analysis is still an indispensable content and teaching method in engineering ethics education.

Except for the classic cases such as “Challenger”, “Chernobyl nuclear accident”, the engineering ethics cases in the textbooks of the United States, whether real or fictional, have a prominent local characteristic. The Chinese textbooks contains some Chinese cases, as well some foreign cases. The fundamental reason is that Engineering Ethics came into Chinese universities very late. Experience of textbooks in other countries were used for reference when compiling Chinese engineering ethics textbooks. Case analysis plays an important role in engineering ethics education, and helps students to understand theoretical knowledge and to apply the knowledge of engineering ethics to specific situations. At the same time, case is also a way for students to learn about engineering activities. Especially the real cases from other countries can help students understand foreign ethical problems of engineering activities. Therefore, the richness and internationalization of the cases is also a problem that the engineering ethics education and the textbooks should care about in the context of globalization.

Moreover, with the help of a MOOC platform and We Chat, an extremely popular social networking tool in China, TB6 presents other cases in the form of QR code. Students can have access to the detailed information of the case through scanning QR code, which provides a large number of cases in a limited textbook length.

## **Conclusions**

To explore “What should be taught in Engineering Ethics Education under Globalization”, the first thing we must know is the current situation of engineering ethics education, that is, the current contents of engineering ethics education. The mutual understanding on the contents of engineering ethics among countries is also an aspect of the internationalization of engineering ethics, which is one of the purposes of this paper to compare and analyze the contents of classical textbooks in different countries. By the comparative study of two of the world’s leading countries in engineering education, the similarities, differences and features of engineering ethics educational contents in both countries are revealed. The generalities reflect the common foci of engineering ethics education. Engineering ethics textbooks set forth the basic concepts, theories and principles of engineering ethics firstly; then according to the special requirements of engineering profession, put forward some issues such as the responsibilities of engineers, stakeholders in engineering, how to practice ethical norms in science and technology activities and engineering practice; and finally probe the practical problems such as ecological responsibilities of the engineers. These generic and common

knowledge are consistent with the goal of engineering ethics education.

Meanwhile, according to the study, it is found that there are obvious differences between different textbooks in the format of compilation, chapter arrangements and contents, which can identify lessons worth learning from each other. Based on the analysis results and the need for globalization, the paper attempts to highlight several key points of engineering ethics educational contents. Although the textbooks of engineering ethics are the main content sources and carriers of engineering ethics education, it does not mean that more contents covered by the teaching materials will be better. Therefore, teachers are required to choose and supplement the contents of the teaching materials in the actual teaching practice. While preserving the common knowledge, it is necessary to form the ethical contents that is suitable for localization and can also satisfy the internationalization. For example, by virtue of the big data and multimedia, teachers can enrich the teaching cases of engineering ethics. Through a variety of cross-cultural cases, students can use what they have learned to experience the real professional ethics and understand the development of international engineering education and engineering ethics. The internationalization of engineering activities accelerates the international mobility of engineering talents, which should not only make the contents of engineering ethics education break the boundary of countries, but also should help students understand the international professional standards and norms of engineering, and gain knowledge of the ethical and cultural characteristics of different countries and regions.

Discussing the contents of engineering ethics education from the perspective of courses and textbooks does not mean that the courses and textbooks are the whole contents of engineering ethics education. Moreover, the potential differences between the “theory” of the classroom and the “practice” of the workplace should not be ignored. It is a crucial question worthy of further in-depth study. Therefore, based on the above study, the authors try to look forward to the future research. On the one hand, the scope of study objects is expected to be further expanded. The textbooks of more countries can be compared and studied so as to comprehensively show the current situation and development trend of international engineering ethics education. On the other hand, more materials could be collected to explore how to bridge the gap between school education and the ethical need of industry in order to prepare engineering students for the realities of the workplace. Due to limited space, the findings which are expected to be helpful to the engineering teachers and students in engineering ethics education are still preliminary. Therefore, further study on engineering ethics textbooks would be conducted to find more similarities and differences in order to better explore the educational contents of engineering ethics education under globalization.

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