Strategies and Effectiveness for Cultivating Global Competence of Engineering College Students under the Internationalization of Engineering Education

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Abstract: Based on the similarities between graduate outcomes described in "Criteria for Engineering Education Accreditation" and global competence defined in "PISA 2018 Global Competence Framework", this study proposed three strategies for cultivating global competence of engineering college students under the internationalization of engineering education: constructing a three-dimensional assessment framework of global competence, namely knowledge, skills, and attitude, establishing a three-dimensional educational system for cultivating global competence, namely curricular teaching, extracurricular activities and international communication, and building multi-modal teaching resources for cultivating global competence. The effectiveness was tested through a year of experiment and the finding showed that there were significant improvements in the students' global competence.

1. Introduction

Under the internationalization of engineering education, engineering college students are expected to achieve graduate outcomes, which is described in the 2017 edition of "Criteria for Engineering Education Accreditation [1]" formulated by China Engineering Education Accreditation Association: Graduates can solve complex engineering problems, evaluate the impact of professional engineering practice and solutions to complex engineering problems on society, have humanities and social science qualities, social responsibility and professional ethics, have international perspective, cross-cultural communication and interaction skills.

In the era of globalization, youth are required to have global competence, which is defined in "PISA 2018 Global Competence Framework [2]" released by the Organization for Economic Cooperation and Development: Globally competent individuals can examine local, global and intercultural issues, understand and appreciate different perspectives and world views, interact successfully and respectfully with others, and take responsible action toward sustainability and collective well-being.

Obviously, there are similarities between graduate outcomes described in "Criteria for Engineering Education Accreditation" and global competence defined in "PISA 2018 Global Competence Framework". Therefore, based on their similarities, this study proposed three strategies for cultivating global competence of engineering college students under the internationalization of engineering education, and the effectiveness was tested through a year of experiment.

2. Strategies for Cultivating Global Competence of Engineering College Students under the Internationalization of Engineering Education

The three strategies for cultivating global competence of engineering college students under the internationalization of engineering education are as follows: constructing a three-dimensional assessment framework of global competence, namely knowledge, skills, and attitude, establishing a three-dimensional educational system for cultivating global competence, namely curricular teaching,

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extracurricular activities and international communication, and building multi-modal teaching resources for cultivating global competence.

2.1 Constructing a Three-dimensional Assessment Framework of Global Competence

Specifically, it is, based on the combination of graduate outcomes described in "Criteria for Engineering Education Accreditation" and global competence defined in "PISA 2018 Global Competence Framework", to construct the assessment framework of global competence designed for engineering college students. In the framework, three dimensions, namely knowledge, skills and attitudes, are included. Among them, the assessment components in the "knowledge" dimension are designed to evaluate the knowledge that engineering college students are expected to acquire when tackling with international engineering problems, such as knowledge about global issues, international rules, international situations, international relations, other cultures, and foreign customs. The assessment components in the "skill" dimension are designed to evaluate the skills that engineering college students are expected to develop when managing international engineering projects, such as foreign language skills, intercultural adaptability, intercultural organization capacity, intercultural communication capacity, intercultural analysis capacity, and intercultural action capacity. The assessment components in the "attitude" dimension are designed to evaluate the attitudes that engineering college students are expected to have in the context of international engineering activities, such as respecting cultural differences, understanding value differences, integrating into local culture, shaping national image, caring for global environment, and taking global responsibility. Thus, based on this three-dimensional assessment framework of global competence, tests can be used to measure global competence of engineering college students, getting the data about what aspects of global competence they don't have, analyzing the reasons why they don't have, and accordingly establish the specific model for cultivating their global competence from these three dimensions.

To conclude, the three-dimensional assessment framework of global competence specially designed for engineering college students can help engineering colleges and universities to establish a targeted educational system for cultivating students' global competence. In other words, the assessment framework is the foundation and premise for the establishment of educational system for cultivating global competence of engineering college students.

2.2 Establishing a Three-dimensional Educational System for Cultivating Global Competence

Specifically, it is, based on the three-dimensional assessment framework of global competence, to construct an educational system for cultivating global competence of engineering college students. In the system, three dimensions, namely curricular teaching, extracurricular activities and international communication, are included. Among them, the curricular teaching consists of three parts: integrating engineering teaching into college English teaching, teaching of general academic English for engineering purposes, and teaching of professional English for engineering. The specific implementation mode is as follows: to integrate project-based teaching related to international engineering issues into college English teaching, to offer the course of general academic English for engineering purposes, and to reform the teaching mode of professional English for engineering. Simultaneously, based on the detailed components of global competence, school teachers can set the corresponding teaching objectives and design the corresponding international engineering scenarios, requiring students to solve international engineering problems with their English writing skills and English communicating, interacting and speaking skills. The extracurricular activities consists of diversified domains: English speech forums and competitions, English debate forums and competitions, moot court, model United Nations, mock international conferences and other public communication activities in which international engineering issues are involved. The specific implementation mode is as follows: to organize the activities regularly, demanding students to make critical and innovative speeches about international engineering issues in English when participating in these activities. The international communication consists of three levels: international interaction and cooperation with engineering students in foreign universities or engineers in foreign companies, discussion and communication with international engineering

students in school, and involvement of international engineering students in school into the extracurricular activities. The specific implementation mode is as follows: to organize online interaction and cooperation in written English and spoken English between engineering students in school and engineering students in foreign universities or engineers in foreign companies as well as face-to-face communication on international engineering issues during their exchange visits, to organize discussion and communication on international engineering issues between engineering students and international engineering students in school, to organize intercultural communication activities in which engineering students and international engineering students in school are both involved in.

To conclude, the three-dimensional educational system for cultivating global competence can help engineering colleges and universities to achieve the education goal for cultivating global competence of engineering college students. In other words, the educational system is the core and key to the achievement of the goal for cultivating global competence of engineering college students.

2.3 Building Multi-modal Teaching Resources for Cultivating Global Competence

Specifically, it is to build multi-modal teaching resources for cultivating global competence of engineering college students, in the form of texts, pictures, images, diagrams, sounds, videos, etc. In the resources, the assessment tests of global competence designed for engineering college students, the global issues related to engineering and the corresponding teaching contents based on these issues, the international engineering situational teaching contents designed in accordance with the three dimensions of global competence, the teaching courseware of project-based engineering English, the teaching courseware of general academic English for engineering purposes, and the teaching courseware of professional English for engineering are included. The specific methods for building the resources are as follows: to collect the existing online resources related to cultivating global competence, to self-construct the resources for curricular teaching, extracurricular activities and international communication, to categorize the resources by the dimension of global competence, the dimension of educational system, the usage, the content, the form, etc.

To conclude, the multi-modal teaching resources for cultivating global competence can help engineering colleges and universities to implement an effective educational system for cultivating students' global competence. In other words, the teaching resources are the support and scaffold for the implementation of educational system for cultivating global competence of engineering students.

3. Effectiveness Analysis

In order to test the effectiveness of the three strategies, a one-year experiment was carried out in five different engineering departments in Guilin University of Electronic Technology. Ten students from these five departments (two from each of them) were selected purposively as the research sample, and a pretest and a posttest was given respectively to measure their global competence using the assessment framework designed for engineering college students, as shown in Table 1:

Table 1 Global Competence Assessment Framework.

Indicators	Weight	Sub-indicators
Knowledge （B1）	25%	1. Knowledge of global engineering issues 2. Knowledge of intercultural engineering issues
Skill （B2）	40%	1. Analytical and critical thinking of complex engineering problems 2. The capacity to engage in respectful, appropriate and effective interactions with others in the international engineering community 3. Empathy 4. Adaptability

Attitude（B3）	35%	1. Be open to people from different cultures 2. Respect cultural differences 3. Respect human dignity 4. Global perspective and responsibility

The pretest results of ten selected students' global competence are shown in Table 2:

Table 2 Pretest Results of Students' Global Competence.

Subject	B1	B2	B3	Comprehensive score
1	75	72	70	71.984
2	81	75	71	74.968
3	78	72	69	72.357
4	77	71	73	73.302
5	81	75	72	75.357
6	79	75	73	75.238
7	80	77	71	75.428
8	76	73	68	71.817
9	74	72	65	69.785
10	83	78	71	76.547

The posttest results of ten selected students' global competence are shown in Table 3:

Table 3 Posttest Results of Students' Global Competence.

Subject	B1	B2	B3	Comprehensive score
1	86	83	80	82.595
2	91	89	83	87.174
3	89	85	80	84.071
4	87	88	83	85.801
5	92	90	84	88.174
6	87	87	85	86.222
7	90	91	81	86.856
8	88	86	87	86.897
9	86	85	85	85.254
10	91	89	83	87.174

By comparing the pretest and posttest results of ten selected students' global competence, it could be concluded that the students' global competence had been significantly improved after one-year experiment. Therefore, it is suggested that, under the internationalization of engineering education, the three strategies, that is, constructing a three-dimensional assessment framework of global competence, establishing a three-dimensional educational system for cultivating global competence, and building multi-modal teaching resources for cultivating global competence, can be used by engineering colleges and universities to cultivate global competence of engineering college students.

4. Conclusion

Under the internationalization of engineering education, how to cultivate global competence of engineering college students has become an important educational objective for engineering colleges and universities. In order to attain this objective, this study proposed three strategies: constructing a three-dimensional assessment framework of global competence, namely knowledge, skills, and attitude, establishing a three-dimensional educational system for cultivating global competence, namely curricular teaching, extracurricular activities and international communication, and building multi-modal teaching resources for cultivating global competence. The effectiveness

was tested through a year of experiment and the conclusion could be drawn that these strategies significantly improved the students' global competence.

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