Field Programs to Accomplish the Learning Objectives for Engineering Courses: A Case Study of the Road Surveying and Design Course at Southeast University, China

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Abstract

Background: China Engineering Education Accreditation Association (CEEAA) emphasizes advancing the learning objective requirements of the Chinese students majoring in engineering disciplines to the international standards. Practical elements of the courses, especially field practices, can facilitate the achievement of the learning objectives in engineering disciplines developed by CEEAA. However, given the various challenges such as budget constraints, safety concerns, and logistics difficulties, field practice programs have not been broadly adopted in engineering education. This paper aims to demonstrate the necessity and significance of field programs in engineering education.

Methods: Using the two-week field program of a course at Southeast University(SEU), China *Road Surveying and Design*, as an example, this study first provides an overview of the practical program, including the selection of the field practice base, assembling of the teaching staff, field program content descriptions as well as administration and safety measures. Afterwards, an integrated evaluation system combining the performance assessment with student questionnaires is described in detail. The questionnaires require students to answer questions on the effectiveness of the field practice program based on self-assessment. Moreover, independent-sample t-tests are conducted to compare the student learning outcomes between the students who have participated in the program and those who have not, and paired T-tests were also performed to compare the improvement of five required abilities between the students who have participated in the program and those who have not based on teachers' evaluation.

Results: Through analyses on the learning experience of the participants of the program from 2009 to 2016, the study demonstrates the effectiveness of the field program in enhancing students' awareness in teamwork, communication skills, as well as the ability of solving practical problems and dealing with the challenges in the engineering field.

Conclusion: This study demonstrates strong evidences in effective student learning through a field program and supports the adoption of field programs in accomplishing the educational requirements of students majoring in engineering set by CEEAA.

Keywords: field practice, accomplishment of learning objectives, road surveying and design

Background

With China becoming a formal member of the "Washington Accord" in June 2016, the concept of engineering education accreditation which emphasizes student-centered, outcome-based education (OBE) and continuous improvement, has been more widely recognized and promoted [1][2]. Practical teaching, especially field practice teaching, is considered to be an important part of engineering education [3][4] and plays a crucial role in cultivating students' ability to combine theory with practice, think independently and communicate, work in a team as well as solve complex problems, and in improving students' sense of social responsibility and interests in engineering [5][6][7].

Compared to common practice teaching course, field practice teaching courses (especially those involving the accommodation at the site of practice) apparently are faced with more difficulties and challenges in such aspects as costs, security, logistics and management [8]. Therefore, it is only worthwhile to make sure that field practice teaching has better support and achievement for the educational objectives of engineering courses. In fact, this also conforms to the input-output balance principle.

Based on the field practice teaching as a part of the course *Road Surveying and Design* in the School of Transportation, Southeast University, China as an example, this paper briefly introduced the selection of the field practice base, assembly of the teaching staff, field program content descriptions as well as administration and safety measures, and then pointed out its strong support for the course training objectives, especially in improving students' personal expression and communication skills, awareness in teamwork and the ability to solve complex engineering problems. Through the questionnaire surveys on the learning outcomes evaluated by the students and the instructors, the results indicate that the field practice program provides good support in accomplishing the educational requirements for students majoring in engineering.

Organization of the field practice teaching program

The Road Surveying and Design is a foundational course for students majoring in roadway engineering and traffic engineering at Southeast University (SEU), China. Since 2009, the field practice program has been carried out annually for ten years. A field practice base has been selected and established to be fully-functional and well-equipped. A practical educational system combining the academic coursework and practical training has been formed with a multi-disciplinary teaching team, which consists of teachers and teaching assistants from different universities and disciplines. Furthermore, the program administrators have developed an assessment and improvement mechanism to continuously improve the educational quality of the field practice program.

Selection of the field practice base

Due to the particularity of the field practice teaching, it is one of the challenges to establish or to share the field practice base with other users to save costs when initiating the program. There always exist many problems in building or selecting the proper base for field practice because of the difficulties in cooperating and coordinating with enterprises or independently managing a base specified for roadway engineering majors. Therefore, based on the principle of mutual benefits, the Xiashu Forest Farm, affiliated to Nanjing Forest University (NFU), China, is selected as the site for the two-week field practice program of the course *Road Surveying and Design*.

The site, a 314.4-hectare forest center, is located in Zhenjiang, Jiangsu Province, China. It is a 90-minute drive from SEU's Jiulonghu main campus. Facilitated with abundant dormitories (130 beds), dining facilities (120 seats) and an experienced staff, the base can provide accommodations for all the participants of the program. With the help of NFU, the practice facilities in the base have been partially funded by SEU. The resource sharing and joint management between NFU and SEU produces a win-win situation for both universities. The field program makes the best use of the existing facilities in the base and improves the infrastructures and management of the forest farm, which in return will benefit practice teams from other universities.

Assembly of the teaching staff

It is generally believed that one of the common deficiencies in traditional engineering education is the disconnected arrangements of courses [9] [10]. In order to better cultivate students' comprehensive abilities, the teaching staff from multiple disciplines play defined roles and cooperate closely, constituting an efficient teaching team for the field program, as presented in Figure 1. Teaching assistants (TAs) are also indispensable in assisting the educational activities as the direct supervisors of the students in the base. Every year about 10 graduate students majoring in roadway engineering or surveying engineering are selected as teaching assistants and trained for a month before the program starts. During the program, the duty of teaching assistants is to instruct the field work, handle emergencies, discover potential dangers and track the progress of the group. By inspecting each group at regular intervals and gathering information from TAs, teachers can provide specific instructions to students in need and adjust the schedule every day. Moreover, to better prepare students for future work and help students develop qualities valued by future employers [11], experts from relevant companies and universities are also invited to be the instructors in the teaching program. The program will then be optimized according to the feedbacks from experts and companies as well as through the self-examination of the teaching team.

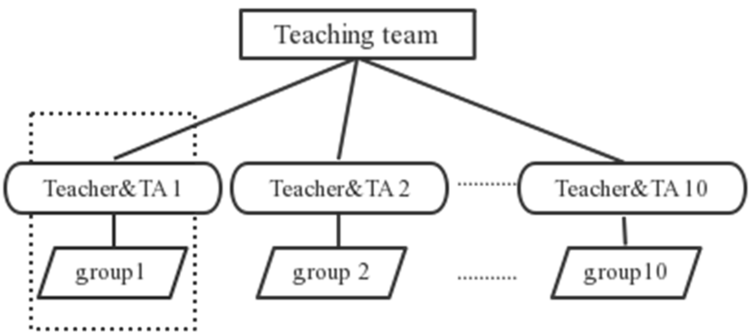

Figure 1 Structure of the teaching team

Field program content descriptions

The main content of the field program is to construct or reconstruct a grade-three fire-proof highway in the forest farm, upon the strips of existing roadways for walking or non-grade highways. Students are required to complete the surveying and designing work outdoors, and to submit design schemes as individuals and a group product at the end of the program. The working contents and procedure of the field program are shown in Figure 2. Students are allocated one or two days to complete each assignment, and the schedule can be adjusted slightly according to students' progress during the program. The contents are generally determined according to the educational requirements and updated to keep up with the latest development of the industry. The field work not only demands a theoretical knowledge concerning highway geometric design, engineering surveying and transport infrastructure, but also requires abilities to operate the instruments, to use design software and new technologies.

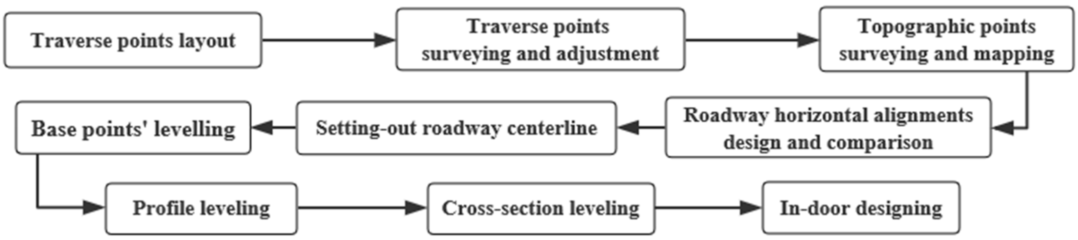

Figure 2 Contents of the field program

The assignments arrangement follows the basic procedure of road construction, providing students with opportunities to experience the future working environment. Through applying theoretical knowledge to practice, participants can achieve further understanding of their profession, deepen their team spirit by communicating and cooperating with group mates, and develop strong personal qualities in unfamiliar and challenging surroundings. Meanwhile, teachers and TAs provide guidance on the operation of surveying and mapping instruments and the use of the computer aided design software, and answer students' detailed questions on site. Different from traditional academic coursework, field practice emphasizes more on the practical abilities and adaptability of the students by solving various engineering and personal problems under different circumstances [12].

Administration and safety measures

In view of the advanced field practice experience in China and western countries [13] [14], an integrated security system is developed to guarantee the safety of the students and teachers at the field base. The security system consists of a legislation system, a prevention system, a supervision and management system, and an accident management system, as shown in Figure 3. As a fundamental basis, the prevention system is critical in guaranteeing the efficiency of the whole security system. The supervision and management system is a necessary supplement of the prevention system to further reduce the potential safety hazards, and the function of the accident management system is to control the damage or exposure of unexpected incidents [3].

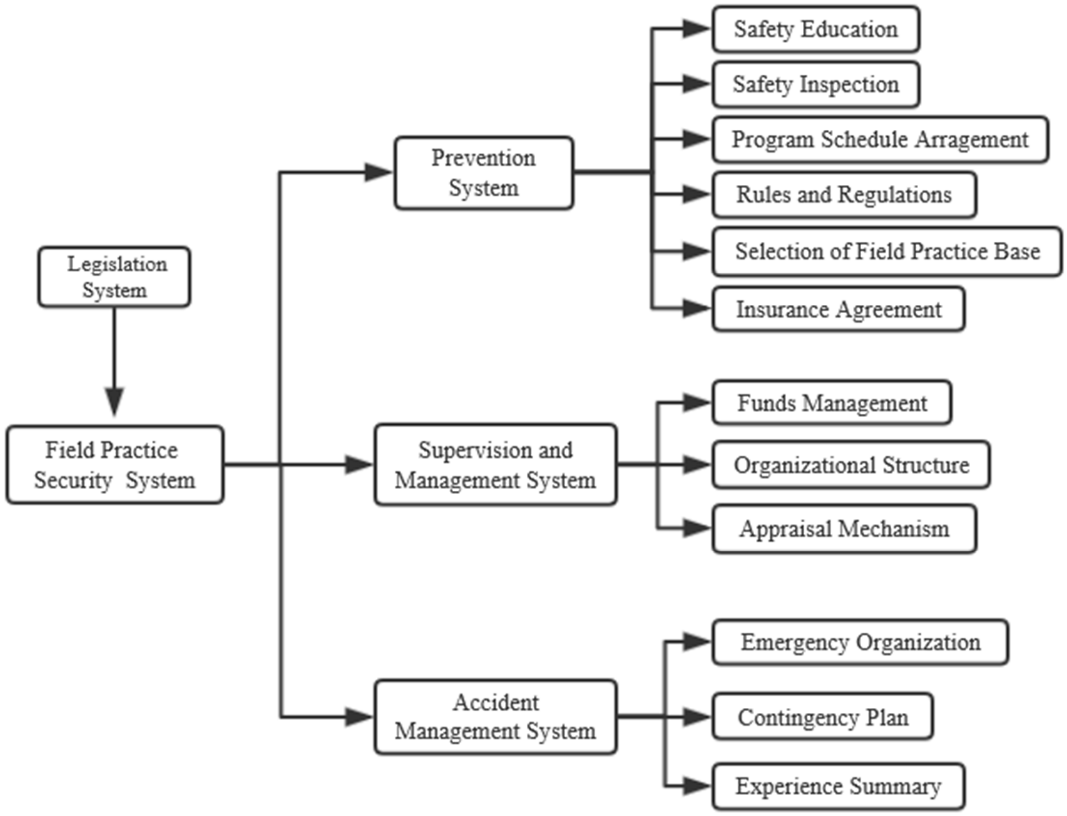

Figure 3 Security system of the field practice

Through the joint efforts of the teaching staff and the administrative staff of the forest farm, there has been no accident during the field program in the last decade. Moreover, according to the educational outcomes of the field program, the administration mode has been dynamically improving every year based on the outcomes and feedbacks.

Evaluation of learning objectives accomplishment

As required by the engineering education accreditation, engineering programs must have a continuous evaluation and improvement process based on documented results [15]. The effectiveness of this field practice program was evaluated with an integrated system combining students' performance and assignments with assessment from students and teachers.

Evaluation based on the students' performance and assignments

An integrated evaluation system combining students' performance assessment with questionnaires for students and teachers is developed to evaluate the accomplishment of learning objectives through this field program. The system consists of evaluation procedure based on the students' performance and assignments as well as an assessment process based on students' self-assessment, and the advantages of the field program in accomplishing the educational requirements were again examined through comparison of the learning outcomes between students who have participated in the field program and those who have not, both from the perspective of students and teachers.

According to the requirements of CEEAA, the learning objectives of the field program were developed and summarized in Table 1. These 12 objectives were classified into three categories, which were professional abilities, personal qualities and interests in engineering. To evaluate the effectiveness of the field practice program in improving the three types of qualities of students, the teaching team developed an assessment algorithm based on students' performance and assignments.

Table 1 the learning objectives of the field program and categories

Learning objective	Category
a. Ability to correctly operate the surveying instruments	Professional abilities
b. Ability to discover and solve practical problems in engineering field	Professional abilities
c. Capability of independent thinking	Professional abilities
d. Capability of data processing	Professional abilities
e. Capability of hardship endurance	Personal qualities
f. Capability of adaptation to environment	Personal qualities
g. Awareness in teamwork	Personal qualities
h. Enthusiasm and sense of responsibility for engineering work	Interests in engineering
i. Communication and expression skills	Personal qualities
j. Confidence and positive attitudes when facing challenges in work	Interests in engineering
k. Ability to use computer-aided design and drafting software	Professional abilities
l. Comprehension of fundamentals for road surveying and designing	Professional abilities

At the end of the course, each student is required to submit a design scheme of the given road assigned to the group they belong to, both a handwritten version and a computer-aided design version. The scheme contains the comparison and selection of schemes, geometric design, earthwork design, drainage design, etc. Moreover, each group is required to provide a joint design work and present it at the final experience sharing meeting. Teachers and TAs grade the performance of each student according to the quality of their assignments as well as their participation in the field tasks and the final presentation. Certain qualities of the students are embedded in their performance during the field study, and their performance can be seen as the indicators of their learning outcomes. Therefore, the scores denoting the accomplishment of objectives concerning the professional qualities, personal qualities and interests in engineering for each student is assessed as follows.

$$X_1 = a * 10\% + b * 10\% + c * 10\% + d * 10\% + k * 30\% + l * 30\% \quad (1)$$

$$X_2 = e * 20\% + f * 20\% + g * 30\% + i * 30\% \quad (2)$$

$$X_3 = h * 50\% + j * 50\% \quad (3)$$

where the lowercase letters a to l represent the score (ranging from 0 to 100) for each learning objective listed in Table 1, and X_1, X_2, X_3 denote scores of the professional abilities, personal qualities and interests in engineering for each student respectively.

Afterwards, the scores are converted to grades in a five-point scale as shown in Table 2.

Table 2 Scores of the learning objectives and the corresponding grade

Score	100~90	89~75	74~60	59~30	29~0
Grade	5	4	3	2	1

Then for all the participants of the field program, the score denoting the accomplishment of learning objectives in each category can be calculated as follows:

$$Y = \frac{\sum G * n}{N} \tag{4}$$

where G denotes the grade for learning objectives in each category and n denotes the number of students graded. N represents the total number of students who participate in the field practice, and Y represents the score denoting the accomplishment for these learning objectives among all the students. A value larger than 3 for Y denotes that the overall students meet the basic educational requirements through the field program, otherwise it is considered that these students fail to realize the minimum requirements with poor accomplishment in the learning objectives. Moreover, the objectives are deemed to be well accomplished if Y has a higher value than 4.

Taking the field program in 2015 as an example, there were a total of 103 participants in the program. The distribution of students' scores in professional abilities, personal qualities and interests in engineering is presented in Table 3.

Table 3 Composition of students' scores for three categories of learning objectives in 2015

Score	100~90	89~75	74~60	59~30	30~0
Professional qualities	31	62	10	0	0
Personal qualities	44	46	3	0	0
Interests in engineering	40	63	0	0	0

Accordingly, the value of Y for professional qualities, personal qualities and interests in engineering is 4.204, 4.010 and 4.388 respectively, indicating excellent accomplishment in all the learning objectives among the students through the field program in 2015.

Evaluation based on students' self-assessment

An online questionnaire was designed for students to assess the effectiveness of the field program from the aspect of their self-assessment. Through a convenient sampling method, the final sample consisted of 398 students who have participated in the field program of the *Road Surveying and Design* course during 2008 and 2016. These respondents were required to report their opinions towards the in-class teaching and the field program, and to identify what kinds of abilities or qualities have been improved for them through the field program.

Among all the respondents, 74.4% of them considered that although the indoor course could provide the basic knowledge of road surveying and engineering, it was difficult for them to have a clear understanding of the practical situations of road projects only through the instruction in class. Over a half of the respondents pointed out that the superiority of the field program lied in its motivational effects on students' independent thinking and learning in comparison to in-class courses, and 45.5% of them considered that the field teaching program created a more practical condition similar to the actual working conditions of road engineers.

Moreover, most respondents believed that their professional abilities, personal qualities and interests in engineering have been strengthened through the field program to some extent. Among the 12 learning objectives mentioned above, more than 70% of the respondents reported that their greatest achievement through this program was the improvement in abilities to correctly operate the surveying instruments and to use the computer-aided design and drafting software. The respondents also reached a consensus on the enhancement effects of the field program on their personal qualities, especially for their capabilities of hardships endurance, adaptation to environment and working in teams. What's more, nearly 50% of them indicated that the field program was also effective in developing work-related responsibilities, and they were better prepared with not only knowledge but also confidence and enthusiasm to be qualified road engineers in the future. Moreover, 96% of the respondents agreed that the field teaching program was necessary in accomplishing the learning objectives for students majoring in roadway engineering.

Evaluation through comparison of learning outcomes from the perspective of students

The road surveying and design course was a foundational course for the second-year students majoring in roadway engineering and those majoring in traffic engineering at SEU. With the same teaching staff and learning objectives, the only difference of the course between these two majors was the form of the practical training project. After the course was finished, students majoring in roadway engineering were required to participate in the two-week program in the field practice base, while those majoring in traffic engineering only need to complete a two-week road design project in door.

Another questionnaire was designed to compare the validity of the field and indoor programs in facilitating the accomplishment of learning objectives for the course. The educational objectives of the road survey and designing course were summarized according to the requirements proposed by CEEAA, and the extent of improvement on each required ability was rated by students on a 5-point Likert scale ranging from 1 (no improvement at all) to 5 (large improvement). Students who took the *Road Surveying and Design* course in 2017 and 2018 were recruited and completed the questionnaire online.

In the 186 questionnaires collected, there were 95 students majoring in roadway engineering and the rest majored in traffic engineering. Three quarters of the respondents took the course in 2018. Independent-sample t-tests were used to compare the 12 learning outcomes between the students in different majors and the results are presented in Table 4.

Table 4 results of the independent-sample t-tests for students' learning outcomes concerning the course

Learning objectives	Students who have participated in the field program (*N*=95)	Students who have not participated in the field program (*N*=91)	t	*P*
Ability to apply the knowledge of math, natural science and engineering	4.16 (0.83)	3.23 (1.02)	6.66	***
Ability to discover and solve engineering problems	4.18 (0.87)	3.38 (1.00)	5.78	***
Ability to design and improve the engineering system	4.05 (0.92)	3.37 (0.97)	4.90	***
Ability in experiment design, operation and data analysis	4.43 (0.83)	3.41 (1.09)	7.20	***
Capability of solving engineering problems with modern tools	4.36 (0.80)	3.54 (1.06)	5.95	***
Accurate understanding of the social effects of engineering practice	4.11 (0.94)	3.04 (0.99)	6.05	***
Accurate understanding of the effects of engineering practice on the substantial development of environment and society	4.04 (0.96)	3.12 (1.06)	6.22	***
Strong work ethics and social responsibilities	4.19 (0.87)	3.51 (1.04)	4.79	***
Awareness and skills in teamwork	4.59 (0.75)	3.40 (1.15)	8.33	***
Capability of communication and coordination	4.55 (0.80)	3.31 (1.03)	9.16	***
Abilities in management of engineering projects	4.25 (0.81)	2.99 (1.01)	9.45	***
Awareness and abilities in lifetime learning	4.27 (0.88)	3.21 (1.15)	6.99	***

Note: *** denotes $P < .001$.

As shown in this table, based on students' self-assessment, students who have participated in the field program reported a greater improvement in all the required abilities than those who have not. The results indicated that students achieved better learning outcomes through the field practice compared to those who only participated in the indoor design project.

Evaluation through comparison of the learning outcomes from the perspective of teachers

To further assess the effectiveness of the field study, the learning outcomes of students were also assessed by the teachers who have directed the field program and the indoor design project. Sixty-seven teachers evaluated the overall performance of students who have participated in the two programs through rating students' improvement in five critical abilities emphasized by both the field and indoor program (i.e. abilities to solve problems in the engineering field, capability of hardship endurance, awareness and skills in teamwork, communication and expression skills and capability of independent thinking) on a 5-point Likert scale ranging from 1 (no improvement at all) to 5 (large improvement) based on their previous experience. Paired t-tests were adopted to compare the differences of the learning outcomes of the students participated in the field program and those in the indoor design program. The results of the paired t-tests are listed in Table 5.

Table 5 results of the paired t-tests for the learning outcomes based on teachers' evaluation

Learning objectives	Through the field program	Through the indoor design program	t	*P*
Abilities to solve problems in the engineering field	3.90 (1.12)	3.55 (1.09)	3.65	**
Capability of hardship endurance	3.85 (1.22)	3.39 (1.11)	3.71	***
Awareness and skills in teamwork	3.90 (1.24)	3.33 (1.13)	5.11	***
Communication and expression skills	3.55 (1.13)	3.42 (1.13)	1.42	NS
Capacity of independent thinking	3.70 (1.07)	3.66 (1.15)	.65	NS

Note: *** denotes $P < .001$, ** denotes $P < .01$, NS denotes non-significant.

As illustrated in the table, there existed some significant differences in the learning outcomes between students who have participated in the field program and those who have not based on teachers' evaluation. The teachers concluded that although the field program and the indoor design project could both enhance the required abilities of students to some extent, the field program was more effective in cultivating several abilities, including the abilities to solve problems in the engineering field, the capacity of hardship endurance as well as the awareness and skills in teamwork. However, the teachers considered that there was no significant difference between the effectiveness of the field program and the indoor design project in improving students' capacity of independent thinking as well as their communication and expression skills.

Conclusion

This paper takes the field teaching program of the *Road Surveying and Design* course in Southeast University, China as an example and provides an overview of the field program from the selection of the field practice base, assembly of the teaching staff, field program content descriptions as well as administration and safety measures. Through the integrated evaluation combining students' performance with their self-assessment, the results demonstrated strong evidence in effective student learning through the field program. The superiority of the field program was again verified based on the comparison of learning outcomes between students who have participated in the program and those who have not, and the evaluation from the perspective of teachers also found support for the adoption of the field program in accomplishing the educational requirements of students majoring in engineering set by CEEAA. The paper provides some insights into designing and implementing the field program of the engineering courses for universities and engineer educators all over the world. Nowadays, with the rapid development of computer-assisted instruction, virtual field practice camp have become an alternative for engineering education for many universities, but they cannot substitute traditional field programs completely [16].

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Reference

[1] M. Chen, X. Dong, J. Liu, Y. Li and J. Guo, "Research and practice on the evaluation methods of the educational accomplishment based on the China Engineering Education Accreditation Standards," *Education Teaching Forum*, vol. 50, pp.109-110, Dec. 2017 (In Chinese).

[2] H.J. Passow and C.H. Passow, "What Competencies Should Undergraduate Engineering Programs Emphasize? A Systematic Review," *Journal of Engineering Education*, vol. 106, pp. 475-526, Jul. 2017.

[3] J. Cheng, W. Qiu, X. Wang, X. Wang and H. Wang, "Research on The Construction of The Security System in The Field Teaching Practice – Taking the courses of transportation and civil engineering in China as an example," *China University Teaching*. vol. 9, pp. 81-86, Sep. 2016 (In Chinese).

[4] S.S. Sheppard, K. Macatangay, A. Colby and W.M. Sullivan, "*Educating Engineers: Designing for the Future of the Field*," San Francisco, CA, USA: Jossey-Bass, 2008.

[5] C. Atman, O. Eris, J. McDonnell, M. Cardella and J. Borgford-Parnell, "Engineering

Design Education," in *Cambridge Handbook of Engineering Education Research*, Ed. Cambridge: Cambridge University Press. 2016, pp. 201-226.

[6] M. Zhang, F. Zhong and J. Yan, "Construction of the Course System for Gas Geology Based on Training Objectives," Education Teaching Forum, pp. 70-73, Jan. 2019 (In Chinese).

[7] X. Liu, S. Zhang, A. Chen, J. Li and B. Li, "Construction of Practical Teaching System for Resource Exploration Engineering in Kunming University of Science and Technology," Chinese Geological Education. vol. 27, pp. 32-35, 2018 (In Chinese).

[8] S. Liu, J. Liu, W. Zhang and C. Chen, "Research on Problem and Strategy for Chinese Engineering Practice Education," in *the 19th International Conference on Industrial Engineering and Engineering Management, IEMI 2013, Changsha, Hunan, China, October 27-29, 2012*, E. Qi, J. Shen and R. Dou, Eds. Berlin: Springer, 2013. pp. 205-212.

[9] H. Liu, F. Bian, F. Chen, K. Li and J. Cheng, "Practice and considerations for shared and co-constructed college field practice bases: taking road surveying and design field practice as an example," *Journal of Architectural Education in Institutions of Higher Learning*. vol. 5, pp: 137-142, 2018 (In Chinese).

[10] R.L. Miller and B.M. Olds, "A Model Curriculum for a Capstone Course in Multidisciplinary Engineering Design," *Journal of Engineering Education*. vol. 83, pp. 311-316, Oct. 1994.

[11] A. Carrillo-Gil, A. A. Carrillo, C. O. Donayre and D. E. Carrillo, "Education and practice: The Peruvian experience," in *the 17th International Conference on Soil Mechanics and Geotechnical Engineering: The Academia and Practice of Geotechnical Engineering. ICSMGE 2009, Alexandra, Egypt, October 5-9, 2009,* M. Hamza, M. Shahien, Y. ElMossallamy, Eds, Routledge, 2009. pp: 2737-2740.

[12] J.B. Ochs, T.A. Watkins and B.W. Boothe, "Creating a Truly Multidisciplinary Entrepreneurial Educational Environment," *Journal of Engineering Education*. vol. 90, pp. 243-250, Jan. 2013.

[13] J. Zhang and R. Wu, "Survey on the Educational Mode for Geology Engineering Practice," *Education Teaching Forum*. pp. 143-145, Jan. 2019 (In Chinese).

[14] Q. Xiao, G. Zheng, Y. Chao, N. Yang and K. Qin. "Survey on the Field Practice Teaching Program for Remote Sensing and Geology Engineering," *Geospatial Information*. vol. 16, pp. 113-116, Dec. 2018 (In Chinese).

[15] S.A. Napper and P.N.J. Hale, "Using Design Projects for Program Assessment," *Journal of Engineering Education*. vol. 88, pp. 169-172, Apr. 1999.

[16] J. Wang, H. Ni, Y. Rui, C. Cui and L. Cheng, "A Web GIS-based teaching assistant system for geography field practice (TASGFP)," *British Journal of Educational Technology*. vol. 47, pp: 279-293, Dec. 2014.