

Analysis of Influencing Factors on Engineering Practice Ability of Students in Applied Universities

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Abstract

Driven by the global technological wave, engineering practice ability has become an important yardstick for measuring the quality of engineering professionals. This article focuses on engineering students in application-oriented universities and explores the current situation and influencing factors of their engineering practice ability. Through methods such as literature review, questionnaire survey and data analysis, a structural framework of engineering practice ability is constructed to analyze the influence of internal factors (such as self-efficacy and engineering concepts) and external factors (such as curriculum setting, teaching methods and practical environment) on ability, aiming to provide talent support for the transformation and upgrading of China's manufacturing industry.

Keywords: *Engineering Practice Ability, Influencing Factors, Students.*

Introduction

Driven by the global technological wave, engineering practice ability has become an important yardstick for measuring the comprehensive quality of engineering professionals (Gou Manli & Xia Guoping, 2025). With the rapid development of science and technology, the engineering field is undergoing unprecedented changes. New technologies and new processes are emerging one after another, which puts forward higher requirements for the practical ability of engineering professionals. Engineering practice ability not only involves the application of professional knowledge, but also includes multiple qualities such as the ability to solve practical problems, innovative thinking, and teamwork. Engineering professionals with solid engineering practice capabilities can better adapt to social demands, promote the smooth implementation of engineering projects, and facilitate the development of the social economy.

In recent years, the state has attached great importance to the reform of engineering education and issued a series of policy documents, aiming to enhance the practical ability and comprehensive quality of engineering students. The "Made in China 2025" plan clearly states that efforts should be accelerated to cultivate high-quality engineering talents who can meet the demands of the transformation and upgrading of intelligent manufacturing and green manufacturing (Chinese Academy of Engineering, 2015). The State Council's "Opinions on Accelerating the Formation of a New Development Pattern" also emphasizes the need to deepen the reform of undergraduate education and teaching and comprehensively improve the quality of talent cultivation (World Bank, 2024; International Monetary Fund, 2024). These policy documents have pointed out the direction for the reform of engineering education and also provided policy support for the cultivation of engineering practice ability.

From the perspective of the international competitive landscape, the strength of engineering practice ability directly affects the competitiveness of a country's manufacturing industry. The World Economic Forum's (2021) Global Competitiveness Report points out that a new round of technological revolution and industrial transformation is reshaping the global economic landscape, and the cultivation

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of talents in the engineering field needs to adapt to the new technological development trends. The "Research Report on the Development Strategy of China's Manufacturing Industry" by the Chinese Academy of Engineering (2015) also emphasizes that the transformation and upgrading of China's manufacturing industry requires a large number of engineering talents with innovation and practical capabilities. Therefore, conducting in-depth research on the talent cultivation plans for engineering majors and strengthening the cultivation of engineering practice abilities is not only an inherent requirement of educational reform but also an urgent need of the national development strategy.

Literature Review

Engineering Practice Ability

Engineering practice ability refers to students' ability to apply the

knowledge they have learned to solve practical problems in the field of engineering, covering both "hard skills" and "soft skills". Among them, "hard skills" include problem-solving ability, engineering design ability and engineering application ability; "Soft skills" involve engineering communication skills, teamwork skills and engineering understanding skills (Kang Ting, 2023). This division of the ability structure is based on the complexity of engineering practice, emphasizing the integration of theory and practice, as well as the comprehensive ability to solve practical problems. Based on previous research, several dimensions of engineering practice ability have been determined, including problem-solving ability, engineering application ability, engineering design ability, engineering communication ability, teamwork ability and engineering understanding ability.

Constructivist Learning Theory

Constructivist learning theory emphasizes that knowledge is

constructed through the interaction between individuals and their environment. In engineering education, students combine theoretical knowledge with practical experience by participating in actual projects, practical courses and extracurricular activities, thereby building up their own engineering practice abilities (Tao Yufei & Guan Zengjian, 2021). This theory highlights the significance of students' active participation and experience accumulation during the learning process. Active participation means that students are not only passive recipients of knowledge, but also active builders of it. By solving practical problems, students can better understand and master theoretical knowledge. The accumulation of experience provides students with a rich practical foundation, enabling them to effectively solve complex problems in the future by applying their existing experience. In addition, situational learning is also an important component of constructivist learning theory. When students learn in real situations, they can better understand the complexity and variability of engineering problems, thereby enhancing their practical abilities. Feedback and reflection are also key links in constructivist learning theory. Through feedback and reflection, students constantly adjust their learning strategies and behaviors, further improving their knowledge systems and practical skills.

Self-efficacy Theory

Self-efficacy refers to an individual's subjective judgment of their

ability to complete a certain task. Research shows that students' self-efficacy has a significant impact on their learning behavior and learning outcomes (Lin Jiao, 2024). In the process of cultivating engineering practice ability, students' self-efficacy will affect their participation in practical tasks and the quality of their completion. Students with high self-efficacy are more willing to participate in practical tasks because they believe they can successfully complete these tasks. This positive attitude helps them devote more energy and time to practice. Meanwhile, students with a high sense of self-efficacy are more likely to persevere when facing difficulties. They are more likely to overcome difficulties through efforts, thereby improving the quality of practical task completion. Self-efficacy is closely related to learning motivation. When students believe they can complete tasks, their learning motivation will also increase, and thus they will participate in learning activities more actively. Furthermore, when facing challenges and failures, students with a high sense of self-efficacy are more capable of maintaining a positive mindset, adjusting strategies, and continuing to strive. This kind of psychological resilience is crucial for the cultivation of engineering practice ability.

Overall Engineering Perspective

The holistic engineering perspective emphasizes the integration of

technical, social, economic and environmental factors in engineering activities. Engineers need to consider the broader impact of their work and develop sustainable and socially responsible solutions (Li Peigen, 2011). This perspective demands the adoption of a comprehensive engineering education approach that goes beyond technical skills. The overall engineering perspective requires engineers not only to master technical knowledge but also to take into account non-technical factors such as society, economy and environment. Therefore, in engineering education, it is necessary to integrate knowledge from multiple disciplines and cultivate students' ability to consider problems as a whole. Sustainable development is an important component of the overall engineering perspective. When engineers design and implement engineering projects, they need to consider the long-term impact of the projects and ensure their sustainability for the environment and society. In addition, the overall engineering perspective also emphasizes the social responsibility of engineers. Engineers' work has a profound impact on society. Therefore, they need to take on social responsibilities in their work and ensure that the implementation of engineering projects is in line with social interests and does not cause negative impacts on society. Systems thinking is also a key element of the overall engineering perspective. Engineers need to consider problems as a whole rather than just focusing on the parts. This way of thinking helps engineers better understand and solve complex engineering problems. Finally, the overall engineering perspective requires engineers to have the ability to collaborate across disciplines. In practical work, engineers need to collaborate with personnel from different specialties to jointly solve complex problems. Therefore, in engineering education, it is necessary to cultivate students' interdisciplinary cooperation ability to meet the demands of practical work.

Research Methods

This study adopts a quantitative research design, aiming to explore the factors influencing the engineering practice ability of engineering students in application-oriented universities. The research plan includes defining research questions, selecting samples, designing questionnaires, collecting data and analyzing results. The research involved senior students majoring in engineering, with samples including students from different majors such as mechanical engineering, electrical engineering, vehicle engineering and civil engineering.

The core issue of this study is: "What factors significantly affect the engineering practice ability of engineering students in application-oriented universities?" To address this issue, the research has been further refined into the following specific questions:

This study constructed a comprehensive conceptual framework to systematically analyze the engineering practice ability of engineering students and its influencing factors. This framework clarifies the relationships among the main variables and provides a theoretical basis for subsequent research design and data analysis. The conceptual model of the research is shown in Figure 1, and all the assumptions about the key influencing factors of engineering practice ability are presented in Table 1.

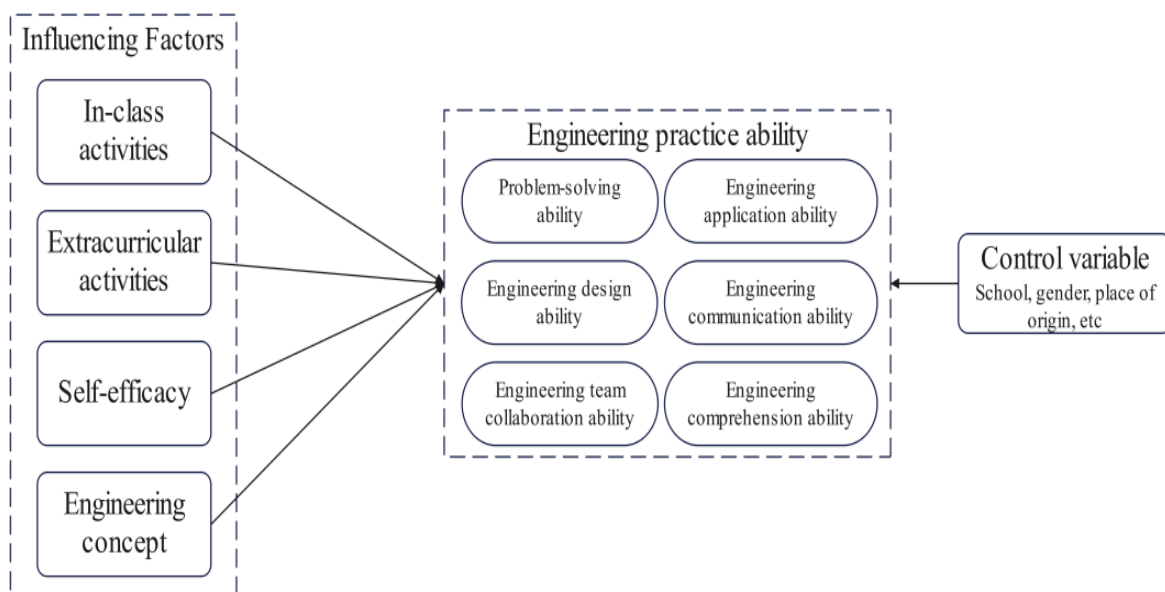


Table 1. All Assumptions Regarding the Key Influencing Factors of Engineering Practice Ability

Research Hypothesis		
The influence of External Factors (In-class Activities) on Engineering Practice Ability (H1)	h1-h6	In-class activities have a significant impact on the six dimensions of engineering practice ability (problem-solving ability, engineering application ability, engineering design ability, engineering communication ability, engineering teamwork ability and engineering comprehension ability)
The influence of External factors (extracurricular activities) on Engineering Practice Ability (H2)	h7-h12	Extracurricular activities have a significant impact on the six dimensions of engineering practice ability (problem-solving ability, engineering application ability, engineering design ability, engineering communication ability, engineering teamwork ability and engineering comprehension ability)
The influence of internal factors (self-efficacy) on engineering practice ability (H3)	h13-h18	Self-efficacy has a significant impact on the six dimensions of engineering practice ability (problem-solving ability, engineering application ability, engineering design ability, engineering communication ability, engineering teamwork ability and engineering comprehension ability)
The influence of Internal factors (Engineering concepts) on engineering practice Ability (H4)	h19-h24	Engineering concepts have a significant impact on the six dimensions of engineering practice ability (problem-solving ability, engineering application ability, engineering design ability, engineering communication ability, engineering teamwork ability and engineering comprehension ability)

Research Tools

In order to gain a deeper understanding of the current situation of engineering practice ability of engineering students in applied universities, this study conducted a comprehensive investigation of engineering students in multiple applied universities through questionnaire surveys and data analysis. The survey content covers six dimensions of engineering practice ability: problem-solving ability, engineering design ability, engineering application ability, engineering communication ability, teamwork ability and engineering understanding ability. At the same time, students' satisfaction with the curriculum design, teaching methods, practical environment and other aspects, as well as their suggestions and expectations for the reform of engineering education, were also investigated.

The questionnaire design referred to the standards of the China Engineering Education Professional Accreditation Association (CEEAA), the National Data Platform for Quality Monitoring of Higher Education in China (CHENES), and research reports from authoritative engineering organizations at home and abroad, ensuring the scientific and practical nature of the questionnaire content. The questionnaire consists of three parts: The first part collects demographic information, including gender, major and place of origin. The second part measures EPA using the Likert scale, which includes 27 items and covers six dimensions: problem-solving ability, engineering application ability, engineering design ability, engineering communication ability, teamwork ability and engineering understanding ability. The third part consists of 23 items for evaluating influencing factors, including in-class activities, extracurricular activities, self-efficacy, and engineering concepts.

Investigation on the basic information of the respondents, their engineering practice ability and the influencing factors of their engineering practice ability. The Likert five-point scoring method is adopted, and the scores are given from five options: "very dissatisfied" to "very satisfied".

The subjects of the questionnaire survey are senior students majoring in engineering from many applied universities, covering major engineering disciplines such as mechanical engineering, civil

engineering, electrical engineering and vehicle engineering. The questionnaire is created and generated as an electronic questionnaire through the Wenjuanxing platform, and the questionnaire link is sent to the target samples. The data collection period was from April 15th to May 15th, 2025. A total of 743 questionnaires were retrieved. Questionnaires with a response time of less than 120 seconds were determined to be invalid. After eliminating 57 invalid questionnaires, 686 valid questionnaires were obtained, with an effective recovery rate of approximately 92.19%. The results of the reliability and validity analysis of the questionnaire show that it has high reliability and validity.

Results and Analysis

Analysis of Engineering Practice Ability

1) Descriptive statistical analysis

Through descriptive statistical analysis of 686 valid questionnaires, it

was found that students' satisfaction with engineering design ability was the lowest (M = 3.82), followed by problem-solving ability and engineering application ability (M values were 3.78 and 3.79 respectively). This indicates that in current engineering education, there is a deficiency in the cultivation of students' "hard skills". The main reason is that the curriculum design emphasizes theory and lacks the cultivation of practical abilities. Table 2 presents the descriptive statistical results of each dimension of engineering practice ability.

Table 2. Descriptive Statistics of Various Dimensions of Engineering Practice Ability by Colleges and Universities

Question item	n	Mean	S.D.
PS	686	3.7813	.75
DC	686	3.8225	.73
AC	686	3.798	.74
CC	686	3.848	.74
TC	686	3.9348	.75
UC	686	3.953	.72

2) Reliability and validity analysis

The internal consistency of the questionnaire was evaluated by

Cronbach's α coefficient, and the structural validity of the questionnaire was evaluated by KMO and Bartlett tests. The results are shown in Tables 3 and 4. The overall Cronbach's α coefficient of the engineering practice ability measurement index part is 0.941, indicating that the overall scale has a very high reliability. The KMO value is 0.863, which is greater than 0.5, and the P value is 0.000 (significance level less than 0.05), indicating that this part of the questions has good structural validity and is suitable for factor analysis.

Table 3. Shows The Overall Reliability Analysis Results of the Engineering Practice Ability Measurement Index Questions

Cronbach's Alpha	Number of items	Sample size
0.941	27	686

Table 4. Shows The KMO And Bartlett's Test Results of the Engineering Practice Ability Structure Index System

KMO value		.945
Bartlett sphere test	Chi-square value	10844.697
	Degree of freedom	351
	Significance probability	.000

3) Factor Analysis

Through factor analysis, six principal components were extracted, and

the cumulative variance explanation rate reached 70.349%, indicating that these six factors can well explain the structure of engineering practice ability. Specifically, engineering practice ability can be divided into six dimensions: problem-solving ability, engineering application ability, engineering design ability, engineering communication ability, engineering teamwork ability and engineering comprehension ability.

Table 5 presents the total variance interpretation results of the measurement indicators for engineering practice ability.

Table 5. Explanation of the Total Variance of Measurement Indicators for Engineering Practice Ability

Component		1	2	3	4	5	6	7
Initial eigenvalue	Total	10.691	2.239	1.693	1.489	1.468	1.413	.568
	Variance %	39.598	8.292	6.271	5.514	5.439	5.235	2.104
	Accumulation %	39.598	47.890	54.161	59.675	65.114	70.349	72.452
Extract the sum of squares and load	Total	10.691	2.239	1.693	1.489	1.468	1.413	
	Variance %	39.598	8.292	6.271	5.514	5.439	5.235	
	Accumulation %	39.598	47.890	54.161	59.675	65.114	70.349	
Rotate the sum of squares for loading	Total	3.544	3.455	3.318	2.930	2.919	2.827	
	Variance %	13.128	12.798	12.289	10.853	10.812	10.469	
	Accumulation %	13.12	25.92	38.21	49.06	59.88	70.34	

Extraction method: Principal Component analysis.

Figure 2 shows the framework of engineering practice ability constructed from the perspective of senior engineering students.

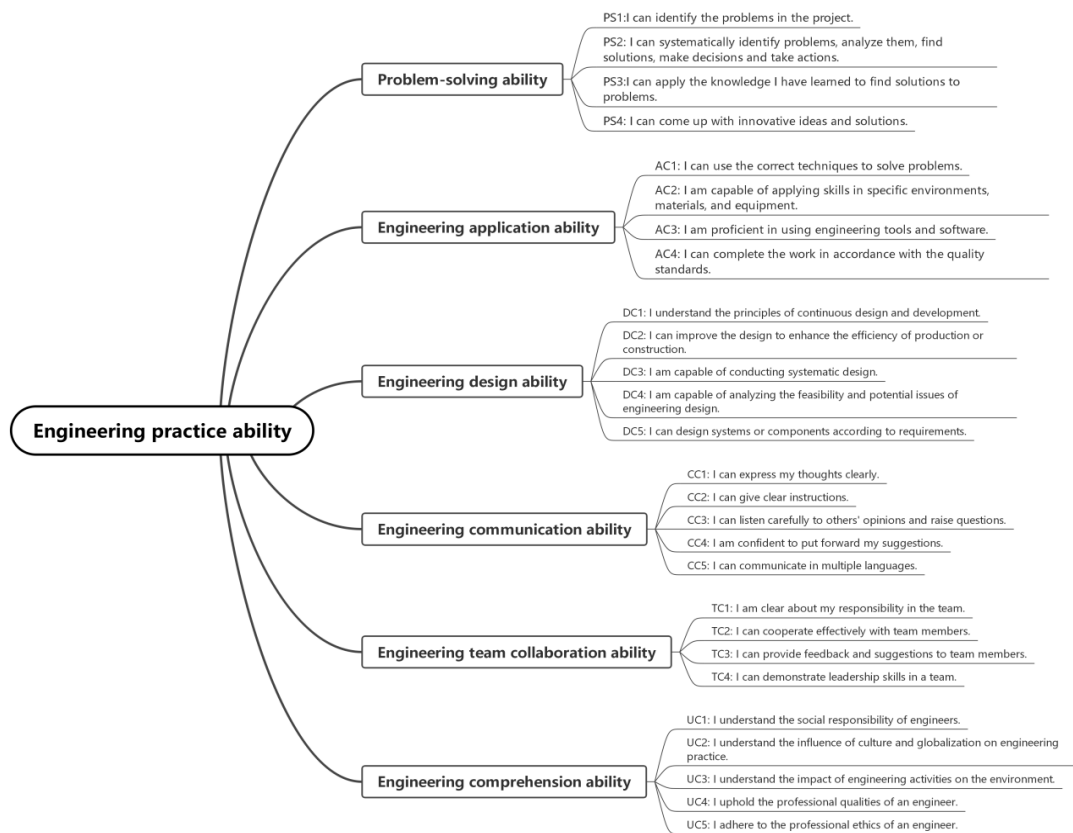


Figure 2 Framework of Engineers' Practical Ability

Key Factors Influencing Engineering Practice Ability

The research constructed an initial conceptual model, proposed four influencing factors: in-class activities, extracurricular activities, self-efficacy and engineering concepts, and put forward corresponding research hypotheses. Through the verification of multiple linear regression analysis and structural equation model (SEM), the following conclusions were drawn from the study:

1) *Multiple linear regression analysis*

Through multiple linear regression analysis, it was found that self-efficacy and engineering concepts have the most significant impact on engineering practice ability. In-class activities also have a certain positive influence, while the influence of extracurricular activities is not significant. Specifically in each dimension, the key influencing factors of problem-solving ability, engineering application ability, engineering design ability, engineering communication ability and engineering teamwork ability mainly include self-efficacy and engineering concepts. In-class activities also play a certain role in this. As for engineering understanding ability, self-efficacy, engineering concepts, in-class activities and extracurricular activities all have a significant positive impact on it.

Table 6. Regression Coefficients and Significance Test Table of Influencing Factors of Engineering Practice Ability

	Non-standardized coefficient		Standardized coefficient	T	Sig	Collinear statistics	
	B	Standard error	Beta			Allowance	VIF
Constant term	.818	.115		7.088	.000		
In-class activities	.072	.019	.094	3.909	.000	.981	1.019
Extracurricular activities	.037	.017	.055	2.255	.024	.968	1.033
Self-efficacy	.322	.021	.432	15.470	.000	.730	1.371
Engineering concept	.328	.021	.438	15.779	.000	.738	1.354

a. *Endent Variable: Engineering Practice ability*

Figure 3 shows the model of the key influencing factors of engineering practice ability (revised).

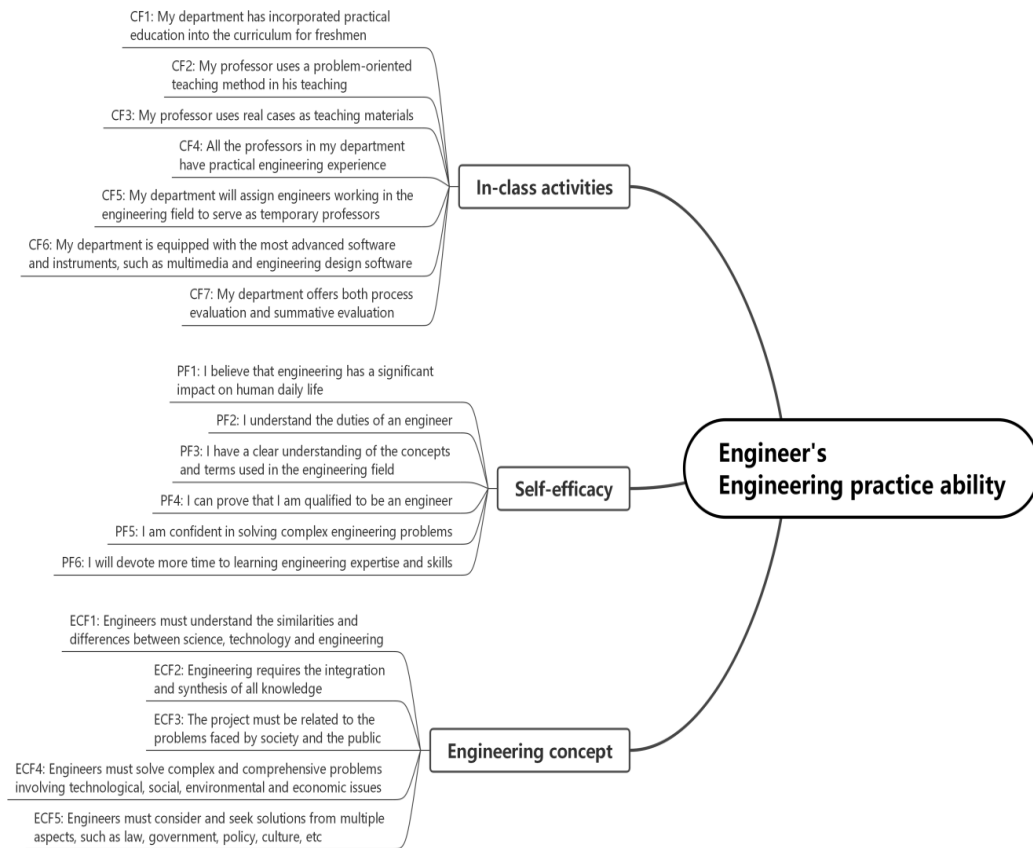


Figure 3 Model of Key Influencing Factors of Engineering Practice Ability (Revised)

2) ② Structural Equation Model (SEM)

Through the construction and verification of the structural equation

model, the final determined model has a good fit degree, and all indicators have reached or approached the ideal standard. The results of the path analysis show that in-class activities, self-efficacy and engineering concepts have a significant positive impact on engineering practice ability, while the influence of extracurricular activities is not significant.

Tables 7 and 8 respectively present the fit indicators of the initial model and the modified model.

Tables 7. Model Compatibility Indicators of Influencing Factors of Engineering Practice Ability

Compatibility index	CMIN/DF	RMSEA	GFI	AGFI	IFI	TLI	CFI
Actual value	1.661	.031	.943	.933	.980	.977	.980

Table 8. Modifies the Model Fit Index

Compatibility index	CMIN/DF	RMSEA	GFI	AGFI	IFI	TLI	CFI
Strict standards	<3	<0.05	>0.9	>0.9	>0.9	>0.9	>0.9
Actual value	1.571	.029	.955	.945	.986	.984	.986
Fitting result	Good	Good	Good	Good	Good	Good	Good

Figures 4 and 5 respectively present the revised structural equation model and the final determined model of the influencing factors of engineering practice ability.

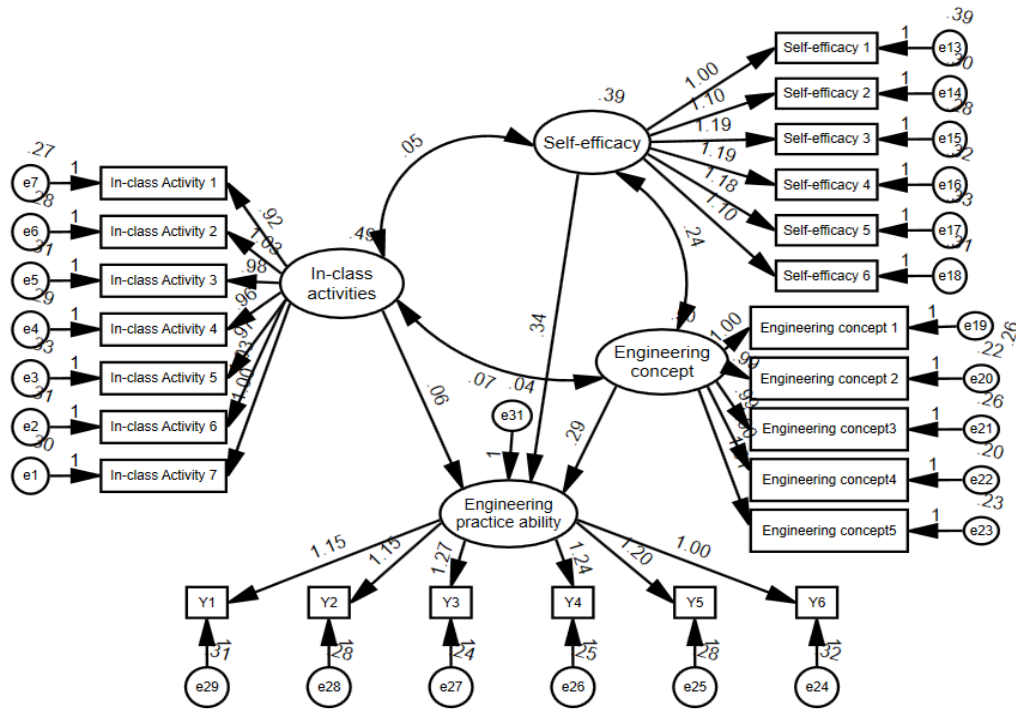


Figure 4 Modified Structural Equation Model of Influencing Factors of Engineering Practice Ability

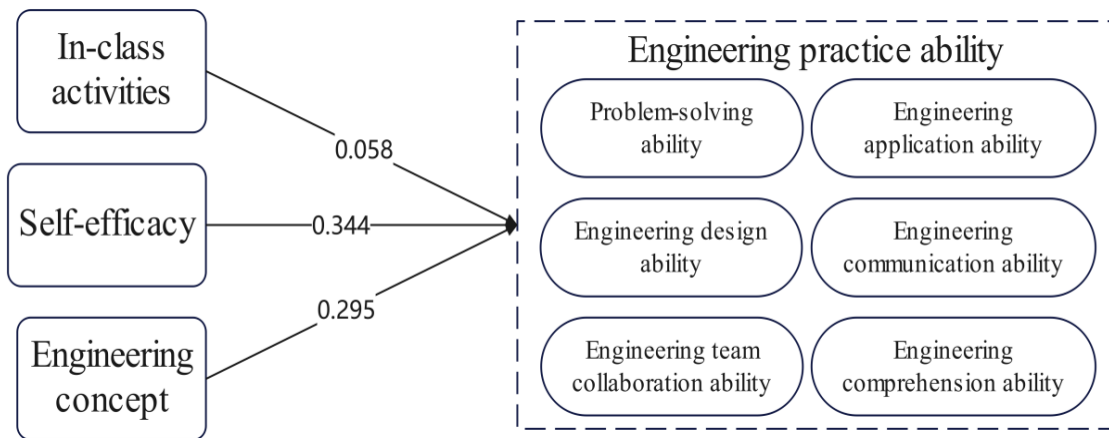


Figure 5 Model of Influencing Factors of Engineering Practice Ability

To sum up, this study draws the following conclusions:

- 1) Engineering practice ability can be divided into six dimensions: problem-solving ability, engineering application ability, engineering design ability, engineering communication ability, engineering teamwork ability and engineering comprehension ability.
- 2) Self-efficacy and engineering concepts are the key factors for enhancing engineering practice ability. In-class activities also have a certain positive impact, while the influence of extracurricular activities is not significant.

Conclusion

This paper systematically studies the engineering practice ability of engineering students in application-oriented universities and its influencing factors, constructs a structural framework of

engineering practice ability, and analyzes the influence of internal and external factors on ability. The research results show that students have certain deficiencies in engineering practice ability, especially in problem-solving ability, engineering communication ability and teamwork ability. Meanwhile, students' satisfaction with the curriculum design, teaching methods and practical environment is relatively low, which indicates that universities need to take further measures in the reform of engineering education. Future research will further expand the sample range, adopt multiple data collection methods, and take into account more potential influencing factors and their interactions, in order to more comprehensively reveal the formation mechanism and improvement path of engineering practice ability.

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