

# Research on blended teaching Mode of Cultivating problem-solving ability-- Take the course "Curriculum Design and Evaluation" as an example

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**Abstract:** Based on the literature analysis, this paper identifies the five factors of problem-solving skills: cognitive ability, knowledge, meta-cognitive ability, motivation, and emotion; teaching intervention strategies; and teaching sessions that affect the development of problem-solving ability. On this basis, a blended teaching mode for cultivating problem-solving ability is designed. The article uses the problem-solving ability evaluation questionnaire to test the effect of pre-test and post-test after teaching intervention on 25 college students. The results verify that the blended teaching model designed in this paper is effective in promoting the cultivation of problem-solving ability, and provide a reference for promoting the cultivation of students' problem-solving ability in the context of the normalization of blended teaching.

**Keywords:** blended teaching, problem-solving skills, teaching mode

## Introduction

In the post-epidemic era, blended teaching has become the norm in college teaching. With the development of technology, social demand for conventional work has decreased, while the demand for non-conventional work has increased significantly. non-conventional work requires individuals to use advanced thinking to solve it, and problem-solving ability is one of the important advanced thinking (Li, 2020). The Core Literacy for Student Development in China emphasizes the development of students' practical and innovative

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skills, of which problem-solving skills are the focus. National Compulsory Education Quality Monitoring Program (Revised Version 2021), which was adopted by the Ministry of Education's party group meeting, proposes that mathematics will mainly test problem-solving skills, among other aspects. It can be seen that Chinese education is placing more and more emphasis on the practical skills that students need to have in the socialization process and on the problem-solving skills that students need when facing complex social environments. However, few studies on hybrid teaching have focused on improving students' problem-solving skills, especially on hybrid teaching models that point to the development of students' problem-solving skills. In addition, few studies have experimentally verified whether hybrid teaching models can promote the development of problem-solving skills. Therefore, this study takes the influencing factors of problem-solving ability as the starting point to build a hybrid teaching model for cultivating problem-solving ability, and uses pre and post-tests to test its effect, aiming to provide a practical path for improving students' problem-solving skills in the blended teaching classroom.

### **Mode Construction: A Blended Teaching Mode for Cultivating Problem-solving Skills**

#### **1. Factors influencing the development of problem-solving skills**

Some scholars explore the influencing factors of problem-solving skills from the perspective of individuals themselves, for example, Li (2020) argues that problem-solving skills are influenced by five aspects: cognitive ability, knowledge, meta-cognitive ability, motivation and emotion, among which cognitive ability is mainly reasoning ability and working memory, and knowledge includes general problem-solving knowledge and related problem-solving strategies. In the teaching process, students

are the main subjects of learning, and teachers occupy a dominant position in the teaching process; therefore, the development of student's abilities is closely related to teachers. Tang (2020) analyzed the influencing factors of problem-solving skills development from two subjects of the teaching process, namely student factors and teacher factors, and pointed out that student factors include reading habits and abilities, learning psychology and habits, thinking styles and cognitive levels, and teachers' influence on students' problem-solving skills mainly through setting up real problem situations and teaching problem-solving strategies. Students learn in the environment and teachers teach in the classroom. Some scholars have explored the influence of environmental factors after considering the influence of subject factors on students' problem-solving skills, and concluded that teacher-student interaction, classroom atmosphere, and campus culture all have an impact on students' problem-solving skills(Ding ,2020). Regarding the above findings, this paper categorizes the influencing factors of problem-solving ability development into cognitive factors, meta-cognitive factors, personality factors, environmental factors, and the factors of the problem itself. Among them, cognitive factors include: thinking styles, stereotypes and functional fixation, transfer and knowledge (structured knowledge and general problem-solving knowledge), personality factors include motivation and emotion, and environmental factors include the authenticity of the problem situation and classroom atmosphere (group work, teacher-student interaction).

#### **2. Intervention strategies based on factors influencing problem-solving skills development**

Through literature research, intervention strategies for problem-solving skills development were proposed based on the five influencing factors for problem-solving skills development above (as shown in Figure 1): free question and answer, task inquiry, reflection and self-questioning, higher order

thinking (characterizing and simplifying problems, thinking from multiple perspectives, and generalizing problem-solving principles).(Chen ,2011) group work, structured knowledge, and authentic problem situations.(Tang ,2020) problem difficulty in the nearest developmental area.(Wu,2009) case studies. (Li ,2006) Multiple evaluation(Hu ,2018)and feedback (Ding ,2020) .

### 3. Teaching sessions based on intervention strategies for problem-solving skills development

The development of problem-solving skills requires teachers to guide students to learn about general problem-solving knowledge, set up teaching activities in real situations, (Li,2020) use multiple assessment methods(Hu ,2018), and choose appropriate teaching methods according to the learning content.(Ding ,2020) It can be seen that the development of problem-solving skills in the teaching process is affected by various complex aspects. Through literature research and a categorization of problem-solving intervention strategies in the existing literature, the development of problem-solving skills

in the teaching process is affected by four aspects of intervention: teaching activities, teaching methods, teaching content, and teaching evaluation, among which teaching activities include free questioning and answering, task exploration, group work, teaching methods include realistic problem situations, problem difficulty, and cases. The teaching content includes reflection and self-questioning, structured knowledge, and higher-order thinking, and the teaching evaluation includes diversified evaluation and feedback.

### 4. Intervention strategies based on problem-solving skills development teaching sessions

The intervention strategies for problem-solving skills development in the above literature are also reflected in four aspects of teaching activities, teaching methods, teaching contents, and teaching evaluation of the teaching mode for cultivating problem-solving skills. By analyzing and categorizing the intervention strategies for problem-solving skills development summarized in the literature, this paper proposes intervention strategies based on the teaching aspects of problem-solving skills development: teaching

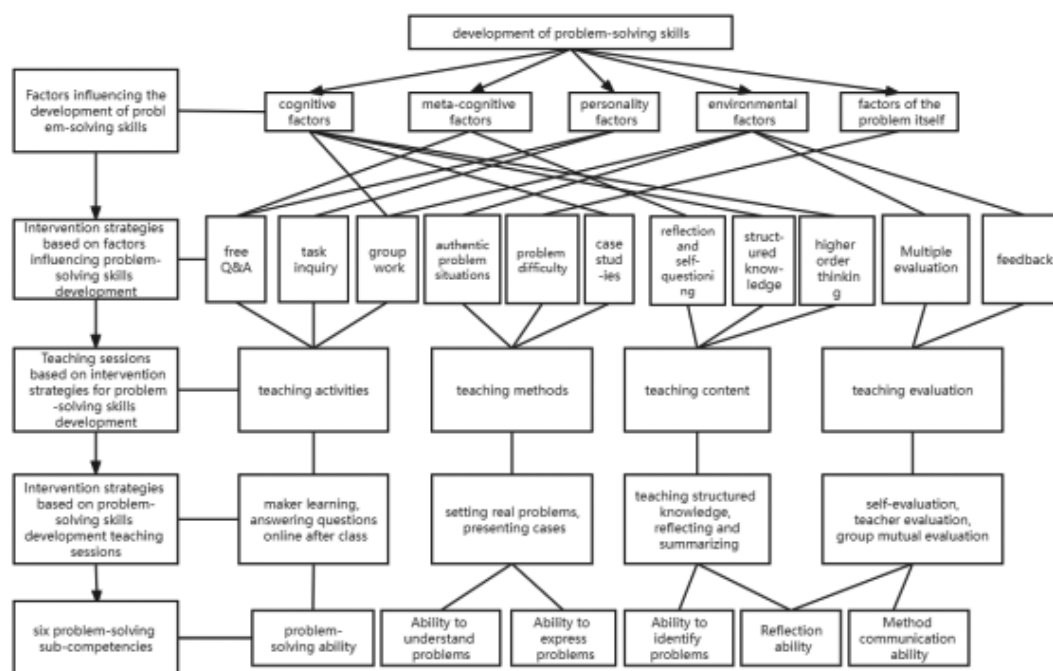


Figure 1 Intervention strategies based on factors influencing problem-solving skills development

activities of maker learning and answering questions online after class, teaching methods of setting real problems and presenting cases, teaching contents of teaching structured knowledge and reflecting and summarizing, teaching evaluation combining self-evaluation, teacher evaluation and group mutual evaluation (as shown in Figure 1). It is worth noting that maker learning is a problem-driven approach that promotes "learning by doing" and allows students to improve their higher-order thinking through collaborative discussion and inquiry.(Zhu ,2021) In the context of information technology, this kind of teaching and learning activity has received more and more attention, and its aspects of task exploration, group work, and promotion of higher-order thinking are compatible with the development of problem-solving skills.

At the same time, PISA 2003 considers that problem-solving skills are composed of the ability to understand problems, identify problems, formulate problems, solve problems, reflect on problems, and communicate methods. The nine intervention strategies proposed in this paper based on problem-solving skills development teaching sessions are in line with the six major abilities of problem-solving ability analyzed by PISA 2003 (as shown in Figure 1). ① Ability to understand problems: provide real problem situations to help students consciously identify problems from learning resources ② Ability to identify problems: master structured knowledge, while providing students with channels for communication, interaction, feedback, and questioning in maker learning, using the given tools and resources to analyze problems and express their own views in discussions ③ Ability to express problems: provide cases to help students perceive the completion effect and guide students to form problem-solving ideas and clearly present them ④ problem-solving ability: students form meaningful discussions in maker learning, teachers provide timely feedback

online and offline, and guide students to choose their own methods and strategies to solve problems ⑤ Reflection ability: reflect on their learning results and summarize their ideas through group mutual evaluation, self-evaluation and teachers' feedback evaluation ⑥ Method communication ability: use mutual evaluation and self-evaluation reflection to carry out method and experience exchange between groups, summarize good experience and find out shortcomings.

### 5. Blended teaching mode for developing problem-solving skills

Huang (2009) constructed a theory of blended course design and proposed three stages of blended teaching mode design, namely, front-end analysis, teaching resources and activities design, and teaching evaluation design, in which, front-end analysis refers to the analysis of teaching contents, teaching objectives and student's characteristics to determine whether the course can carry out blended learning; teaching resources and activities design refers to the design of the content and sequence of learning activities on the premise of determining the learning objectives; teaching evaluation design refers to the evaluation of students' performance and knowledge during the whole learning process.[9] A blended teaching mode for developing problem-solving skills was designed based on this design theory and the proposed seven intervention strategies for developing problem-solving skills (as shown in Figure 2).

Based on the theory of blended teaching mode design proposed by Rong-Huai Huang, this study carries out the design of blended teaching mode for developing problem-solving ability from three parts: front-end analysis, teaching resources and activity design, and teaching evaluation design. Front-end analysis means that before the teaching activities begin, teachers should interpret the teaching contents, analyze the teaching materials, determine the important and difficult points, grasp the interests

and knowledge bases of the students in the class, and determine the teaching objectives according to the teaching contents and learning conditions. Teaching resources and activity design are divided into three parts: before class, during class and after class. Before class, students study the teaching videos released by the teacher in advance through the online teaching platform independently, at this time, the teacher releases the mind map of this chapter on the online learning platform, and the questions arising from the online learning part before class solved by finding data on their own firstly or asking the teacher in the offline class; the part of during class is the offline face-to-face class, firstly, the teacher answers the questions raised by students through online learning, then explains the key and difficult points of this course, and displays the mind map to promote the construction of students' structural knowledge. After the explanation of the knowledge points, the teacher shows the real task situation and assigns the task, and at the same time guides the students to characterize and understand the task, and gradually simplify and decompose the problem, in addition, the teacher needs to show the students similar case to facilitate their perception of the completion effect. Students group themselves according to the task list, determine the division of group work, understand and think about a problem from multiple perspectives and determine the preferred solution. During the period, students can ask teachers for help, teachers carry out targeted inspiration and guidance, and finally, each group

shows the results of the group online or offline in groups. Other groups can evaluate the group's programs. After evaluating the works of other groups, each group evaluates their programs. The teacher organizes students to reflect on the whole process of implementing the previous tasks and summarizes the reasons and methods for taking solutions at each step; after the class, the teacher answers students' questions online and offline and evaluates the progress of completing the online course before the class, students' task results and classroom performance during the class. Finally, the teaching evaluation design adopts a multi-mode and multi-agent evaluation method,

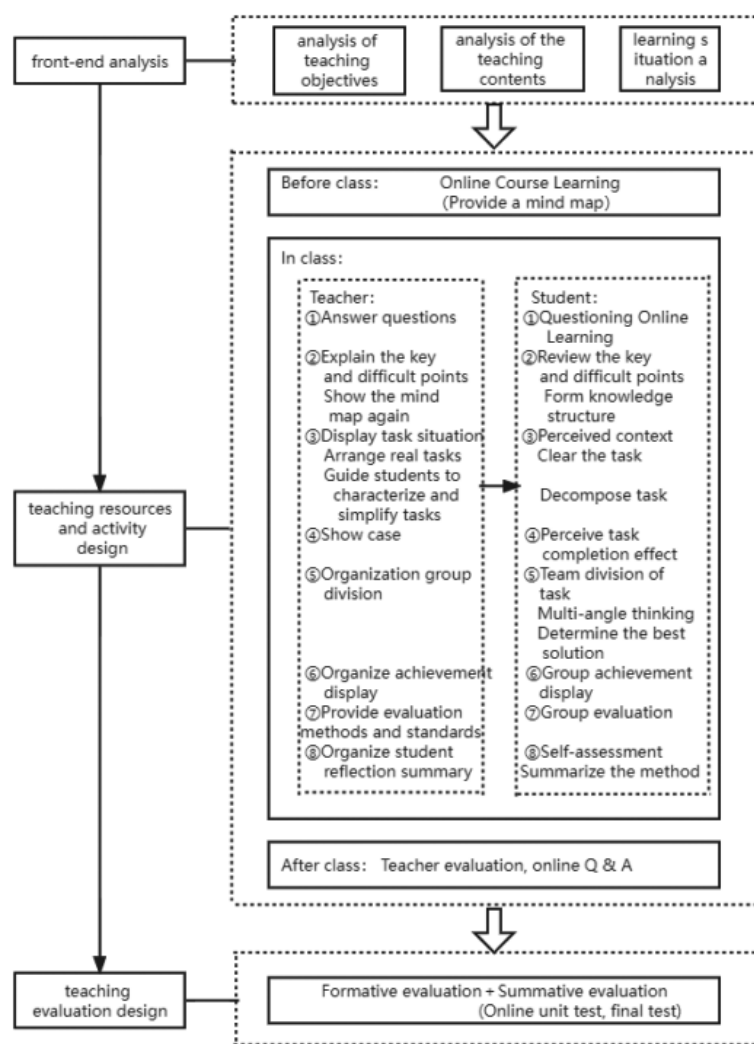


Figure 2 Blended teaching mode for developing problem-solving skills

combining process evaluation with summative evaluation. The summative evaluation includes an online unit test and a final evaluation.

## Method

### 1. Experimental purpose

The main purpose of this study is to cultivate students' problem-solving skills as a criterion under the guidance of a blended teaching mode for cultivating problem-solving skills, to implement teaching intervention strategies, and conduct data collection before and after the course to analyze the effect of this practice and verify that the student's problem-solving skills were developed.

### 2. Experimental design

In this study, 25 students who chose Curriculum Design and Evaluation as an elective course in the second semester of the academic year 2021-2022 at Wenzhou Institute of Technology were selected as the subjects of this study. The class majored in Computer Science, Mechanical Engineering, Statistics, Chinese Language and Literature, English, Visual Communication and Design., and implemented semester-long blended teaching to cultivate problem-solving skills from March to June 2022. The pretest and post-test design without a control group was used in the study, and the measurement was carried out in

the first week and the last week of the semester. The independent variable was the intervention strategy to promote the development of problem-solving skills in blended teaching, which is operationally defined as shown in Table 1, and the dependent variable was problem-solving skills, which consisted of six dimensions: the ability to understand problems, the ability to identify problems, the ability to characterize problems, the ability to solve problems, the ability to reflect, and the ability to communicate methods. The differences between the pre- and post-tests were analyzed to see if the intervention strategies proposed in this study to cultivate student's problem-solving skills would significantly improve students' problem-solving skills. The pre- and post-tests were administered to the same main test, and the questionnaires were distributed to the whole class for approximately 5 minutes, and the questionnaires were collected on site.

### 3. Experimental materials and tools

Experimental materials: In this study, chapters 5 to 11 of the course "Curriculum Design and Evaluation" were selected as experimental materials, and the course was accompanied by a MOOC with a total learning time of 12 weeks and 32 hours.

Experimental tool: The problem-solving ability questionnaire designed by Ma (2020) was used to measure problem-solving skills in this study.

**Table 1 Experimental teaching intervention strategies and operational definitions**

Teaching Sessions	Instructional intervention strategies	Main operation definition
Teaching Activities	Maker Learning	Collaborative group work on structured knowledge progression tasks
	Online Q&A after class	Teachers provide answers or feedback to students' questions in the learning platform after class
Teaching style	Real Questions	Ask real-life, relevant questions or tasks based on learning content and students' lives
	Show Case	Show similar cases in classroom teaching, students perceive the completion effect
Teaching content	Structured Knowledge	Provide each chapter knowledge mind map, summarize structured knowledge in class
	Reflection and Summary	Provide reflection sheets as a scaffold for student reflective summaries
Teaching evaluation	Process evaluation and summative evaluation such as self + group + teacher	Show the results of group cooperation and conduct group mutual evaluation, self-evaluation, and teacher evaluation.



The questionnaire refers to the observation and evaluation criteria of students' problem-solving skills development by Yang Bin and integrates PISA2003, PISA2012, and PISA2015 evaluation questionnaire, and is designed around the six problem-solving sub-competencies of the international PISA2003 evaluation framework (ability to understand problems, ability to identify problems, ability to characterize problems, ability to solve problems, ability to reflect, and ability to communicate methods). The 25 objective questions were designed with high reliability and validity.

#### 4. Experimental teaching process

According to the blended teaching mode designed to cultivate problem-solving ability (as shown in Figure 2), this study conducted experiments in the elective class of "Curriculum Design and Evaluation" in the second semester of the 2021-2022 academic year of Wenzhou Institute of Technology. The teaching process of the experiment is as follows: online course learning, displaying the chapter's mind map → teacher answers students' online learning questions, explains important and difficult points, assigns real tasks, and displays cases → group cooperation to complete tasks → task results display and group mutual evaluation

→ using the group reflection table to conduct self-evaluation and reflect on the task completion process and summarize the principles → teacher evaluation and online Q&A → students make Program revision.

## Results

In this study, a pre and post-test were administered to the learners to measure their problem-solving skills before the start of the 1st week of the course and after the end of the 17th week of the course. 25 participants participated in the questionnaire and 21 valid questionnaires were recovered. A paired-sample t-test was conducted on the recovered data using the data statistical software SPSS21 to compare and analyze the differences in learners' problem-solving skills and their six sub-competencies before and after the intervention.

Overall, students' problem-solving skills were significantly improved after the entire blended teaching to improve problem-solving skills ( $t = -3.823$ ,  $p < 0.01$ ;  $M \pm SD$  before =  $89.95 \pm 14.299$ ,  $M \pm SD$  after =  $105.48 \pm 10.870$ ). Specifically, from the six sub-dimensions of problem-solving ability, students' ability to understand the problem (U) ( $t = -2.922$ ,  $p$

**Table 2 Results of paired-sample t-tests of learners' six problem-solving sub-competencies before and after the intervention**

	Average value	Standard deviation	Standard error of the mean	95% confidence interval of the difference		t	df	Sig. (Bilateral)
				Lower limit	Upper limit			
<b>a-b</b>	-15.524	18.608	4.061	-23.994	-7.053	-3.823	20	0.001
<b>Ua-Ub</b>	-2.524	3.958	0.864	-4.325	-0.722	-2.922	20	0.008
<b>Da-Db</b>	-2.381	2.854	0.623	-3.680	-1.082	-3.822	20	0.001
<b>Ca-Cb</b>	-2.762	3.015	0.658	-4.134	-1.389	-4.198	20	0.000
<b>Sa-Sb</b>	-2.143	3.260	0.711	-3.627	-0.659	-3.012	20	0.007
<b>Ra-Rb</b>	-2.952	3.905	0.852	-4.730	-1.175	-3.465	20	0.002
<b>Ma-Mb</b>	-2.762	3.673	0.802	-4.434	-1.090	-3.446	20	0.003

Note. in the table, a represents pre-test data and b represents post-test data, \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

$< 0.01$ ;  $M\pm SD$  before  $=14.95 \pm 2.837$ ,  $M\pm SD$  after  $=17.48 \pm 1.990$ ), ability to identify the problem (D) ( $t = -3.822$ ,  $p < 0.01$ ;  $M\pm SD$  before  $=14.90 \pm 1.972$ ,  $M\pm SD = 17.48 \pm 1.990$ ), ability to identify the problem (D) ( $t = -3.822$ ,  $p < 0.01$ ;  $M\pm SD = 14.90 \pm 1.972$ ,  $M\pm SD$  after  $=17.29 \pm 1.821$ ), ability to characterize the problem (C) ( $t = -4.198$ ,  $p < 0.001$ ;  $M\pm SD$  before  $=14.71 \pm 2.327$ ,  $M\pm SD$  after  $=17.48 \pm 2.040$ ), ability to solve the problem (S) ( $t = -3.012$ ,  $p < 0.01$ ;  $M\pm SD$  before  $=15.48 \pm 2.400$ ,  $M\pm SD$  after  $=17.62 \pm 2.133$ ), the ability to reflect (R) ( $t = -3.465$ ,  $p < 0.01$ ;  $M\pm SD$  before  $=19.38 \pm 2.783$ ,  $M\pm SD$  after  $=22.33 \pm 2.595$ ), and the ability to communicate methods (M) ( $t = -3.446$ ,  $p < 0.01$ ;  $M\pm SD$  before  $=10.52 \pm 3.776$ ,  $M\pm SD$  after  $=13.29 \pm 2.327$ ) were significantly different and significantly higher on the post-test than on the pretest before after the implementation of the blended teaching strategy to improve problem-solving skills. Among them, the most significant improvement in the ability to reflect, ability to communicate methods, and ability to characterize problems was observed, with a mean difference of more than 2.7 on the pre and post-tests.

## Discussion

Students' problem-solving skills were improved after the blended teaching to cultivate problem-solving skills, indicating that the blended teaching mode can improve students' problem-solving skills to a certain extent. Further analysis of the dimensions of learners' problem-solving skills showed that the blended teaching process and strategies proposed in this paper have more positive effects on improving students' ability to characterize problems (C), ability to reflect (R), and ability to communicate methods (M).

The most significant improvement in the three sub-competencies of problem characterization, problem reflection, and method communication is probably because the fact that the experimental

course in this study was designed to synchronize the learning of the content with the practical design of the course outline, that is, students learned the content of the course and designed the course outline at each stage accordingly, resulting in a complete course outline at the end of the course. This course design combines the knowledge points with the logical progressive relationship with the practical operation. In the actual course outline design process, students understand how to decompose tasks and deepen their understanding of the relationship between knowledge points. Therefore, it is obvious to guide students to simplify representation problems and structured knowledge in the mixed teaching of cultivating problem-solving ability. At the same time, the course embeds students' self-evaluation and reflection, group mutual evaluation, and teacher evaluation into the during-class and after-class. According to the teacher's evaluation of the previous course, the group's work is improved and perfected in the next offline class. In the whole course teaching, a closed loop of evaluation, reflection, and improvement is formed, which promotes students' improvement in problem reflection and method communication.

This study compares the existing literature, points out four teaching sessions that effectively promote the development of problem-solving ability, and designs a blended teaching mode for cultivating problem-solving ability based on this, selects the course "Course Design and Evaluation" to design and implement the teaching process, and conducts a pre and post-test comparison study on the students of the course. The study data proved the effectiveness of the mode in cultivating problem-solving skills and achieved the expected experimental results. Since the course class selected for the experiment was taught in a blended teaching mode before, but there was no standardized and rigorous teaching process, considering the ethical issues of educational experiments, it is impossible to set the course class into a traditional teaching



process as control class and experimental class for comparative study. Therefore, the course class with a traditional teaching process can be selected for the design of a blended teaching process subsequently, and the control group and the experimental group were set up to conduct a comparative study of quasi-experiments to improve the scientific rigor of the

experimental results and further prove the validity of the results of this study. At the same time, this study is conducted to cultivate problem-solving ability research, the experimental period is relatively short, which requires further follow-up on the experimental effectiveness in the subsequent study.

## References

- Li, J. J., & Chen, L. (2014). The Predicament and Countermeasures of the Operating Mechanism of "Enrollment and Diversion Training"-- Taking Business Administration Majors as an Example. *Heilongjiang Researches on Higher Education*, (08), 81-83
- Li, Y. M., Lai, J. (2020). The concept, influencing factors and cultivation strategies of complex problem-solving ability. *Journal of Beijing Normal University (Social Science Edition)*, (05), 36-48.
- Tang, B., Nie, X. Y. (2020). Research on the causes and countermeasures affecting the development of elementary school students' mathematical problem-solving ability. *Basic Education Curriculum*, (02), 47-53.
- Ding, F. J. (2020). Research on problem-solving ability of engineering undergraduates and its influencing factors. *China Higher Education Research*, 2020(05):17-23. <http://doi.org/10.16298/j.cnki.1004-3667.2020.05.03>.
- Chen, Q., Liu, R. (2011). *Educational psychology*. Beijing: Higher Education Press.
- Wu, J. H. (2009). Cultivation of students' problem-solving skills in classroom teaching. *Educational Research and Experimentation*, 2009(06):45-49.
- Li, T. J., Wu, Q. L. (2006). On the ability of solving poor structural problems and its cultivation. *Journal of East China Normal University (Education Science Edition)*, 2006(01), 63-68+75. <http://doi.org/10.16382/j.cnki.1000-5560.2006.01.010>.
- Hu, Y., Dong, Y. Q., Yang, M. (2018). Construction of students' problem-solving ability model in flipped classroom model. *Modern Distance Education*, 2018(01), 26-34. <http://doi.org/10.13927/j.cnki.yuan.2018.0005>.
- Zhu, L., Hu, S. Y. (2021). Research on the application framework of creative learning oriented to problem-solving ability--an analysis based on four rounds of iterative experiments and quasi-experiments. *Modern Educational Technology*, (12), 119-126.
- Huang, R. H., Zheng, L. Q., Zhang, H. S. (2009). Curriculum design theory based on blended learning. *Journal of Electronic Education Research*, (01), 9-14.
- Ma L. (2020). Research on problem-solving ability development of college students based on online learning space[Unpublished master's thesis]. Northeast Normal University.