

Teaching Method Design in Engineering Bidding Course Based on Integration of Problem Chain and Mind Map

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Abstract. As a typical course of which contents are full of "text", "engineering bidding" always exists challenges and difficulties in the "teaching" for the science and engineering teachers and in the "learning" for the students. This paper takes the "engineering bidding" course as an example, and puts forward the design principle of the teaching method based on the integration of problem chain and mind map. It clarifies the design method of problem chain in teaching, the application method of "Hall Three-dimensional Structure" model in the construction of knowledge system, and how to use flipped classroom, logical reasoning and 5W1H to enhance the application of problem chain and mind map before, during and after class. Through the integration, the students can construct a framework of knowledge system more effectively. It can also mobilize the initiative of students, improve the fun and efficiency of the classroom as well as stimulate the innovation of learning.

1. Introduction

The engineering bidding course involves the knowledge of bidding regulations, engineering contracts and practical operation procedures. For a long time, case teaching and operational simulation have been the important means to improve engineering bidding teaching. However, case teaching tends to lead to fragmentation of knowledge, while operational simulation is more about developing students' skills from the perspective of skill training. Therefore, this paper will propose a teaching mode that integrates problem chain and mind map, which can be applied to emphasize the teacher's problem-oriented instructional design method and the students' logical thinking ability training before, during and after the class. Furthermore, it provides reference for the teaching courses in engineering management majors similar to engineering bidding course.

The problem chain teaching model was first developed according to the problem teaching proposed by the former Soviet Academy of Sciences academician Mahmutov. Previously, the problem chain was applied and practiced in different subjects. Lu Xiaohua applied it to the teaching of high school history class [1]. Zhang Wei applied it to the teaching of higher vocational physiology [2]. In the field of higher engineering education, Yan Shengmao applied it to the teaching of automatic control principle [3]. Xu Wenyi applied it to mechanics teaching [4]. The problem chain teaching mode focuses on the design of knowledge system and problem discovery, and the mind map teaching mode gives how to answer questions and make it easier to understand and memorize. The mind map is an effective method invented by Tony Bozan, the father of memory and the brain development expert in the UK. Zhang Ganghua applied it to the teaching in high school physics. Sun Lingyu applied it to the teaching of computer data structure [5]. Wu Shengji and others applied it to the teaching in

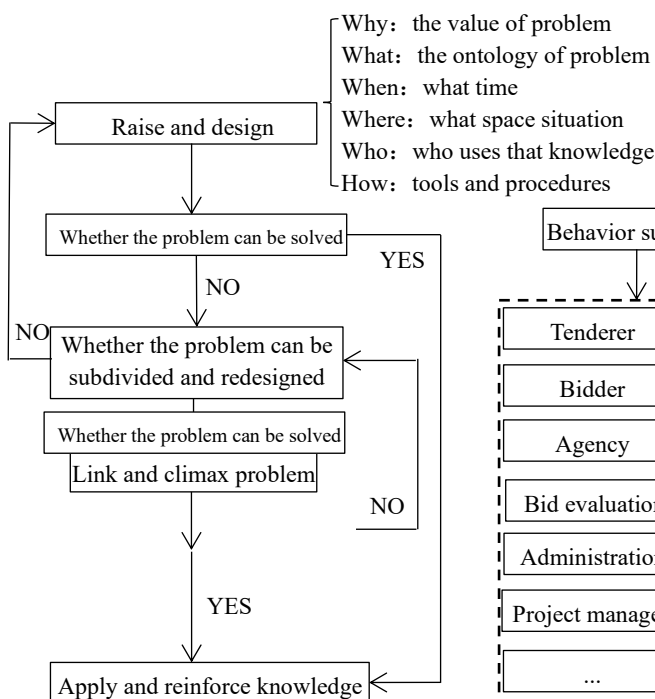
environmental engineering professional course [6].

In summary, considering the advantages of problem chain and mind map in training students to construct knowledge system, discover problems, cultivate scientific spirit, and solve problems, this paper will focus on the characteristics of engineering bidding course and the challenges of teachers' one-side classroom teaching, and propose the teaching method of engineering management course integrating problem chain and mind map, where the teaching of engineering bidding course is taken as an example to illustrate.

2. Design Principles of Problems and Analysis Framework of Designing Problem Chain

It is more important to find problems than to solve them. Condensing problems and passing them on to students, students can be encouraged to learn by themselves. The design of the problems should first be based on the value of the problem (Why). Then, to clear what kind of knowledge is (What). After that, it is necessary to examine what time (When) and what kind of space situation (Where) to use. For example, legal knowledge not only contains timeliness, needed to adjust according to social changes, but also considering the social, political and cultural environment of different regions to use, especially for the knowledge of the "standard operation procedure", such as "engineering bidding management". And then to identify who (Who) uses that knowledge. Finally, specific knowledge can be applied by people, and tools and procedures (How) for knowledge application needed to be clarified, such as software, tools and mastering clear operation procedures

(a) Design principles of problem chain



(b) Problem chain example

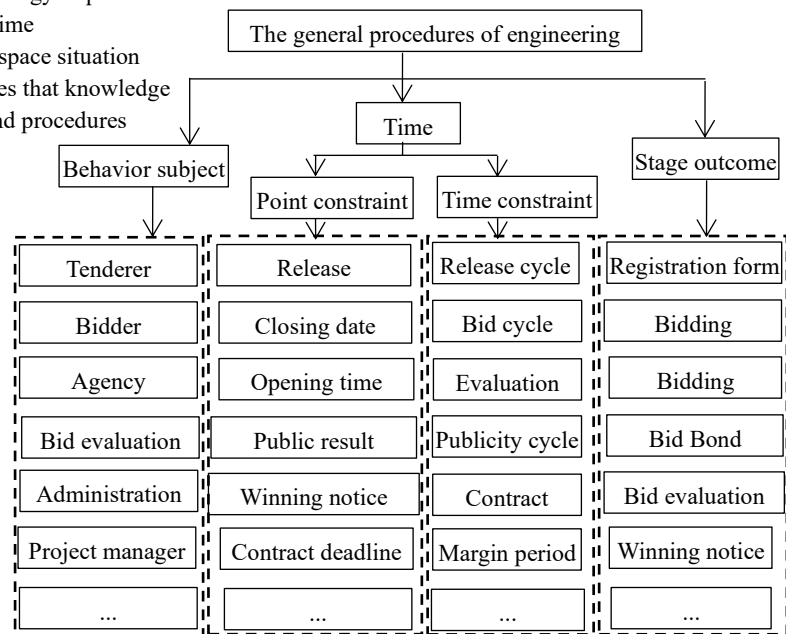


Fig 1. Analysis framework and problem decomposition examples of problem chain in design.

It is helpful for students to internalize knowledge and cultivate the systematic thinking when the 5W1H standard is clarified. As shown in Figure 1-(a), it is the design principles of problem chain, which is based on the chain reaction of problems. Then deepening the logical

reasoning to form a pyramid "chain" of the system. Figure 1-(b) presented the overall decomposition process of problem chain in engineering bidding. First of all, the "overall program" makes clear what the "behavior subject" should do at different time stages under the constraints of time logic, namely "program", and the transformation of the program needs to clarify specific transformation conditions, namely "stage results". According to the structure division of "behavior subject", "practical logic" and "stage achievement", students can set up a systematic knowledge concept even if they cannot solve this problem temporarily.

3. Guide Students to Construct Knowledge System Based on "Hall Three-dimensional Structure" Model

It is important to systematize knowledge for students to construct a systematic grasp of knowledge. In this context, "Hall Three-dimensional Structure" model helps students establish knowledge system and form their logical thinking structure. For example, the three-dimensional structure of "behavior subject" + "time stage" + "X" can be reconstructed for any system with human (including group) participation. "X" can be the work target pursued by "behavior subject" at "different time" stage or the tool used, etc. Based on this, the engineering bidding course can be carved into a work system with three logical dimensions: time, marked achievement and behavior subject. Through such division, not only can the bidding work be defined as a procedural work, but also how many participating units there are in each procedure link.

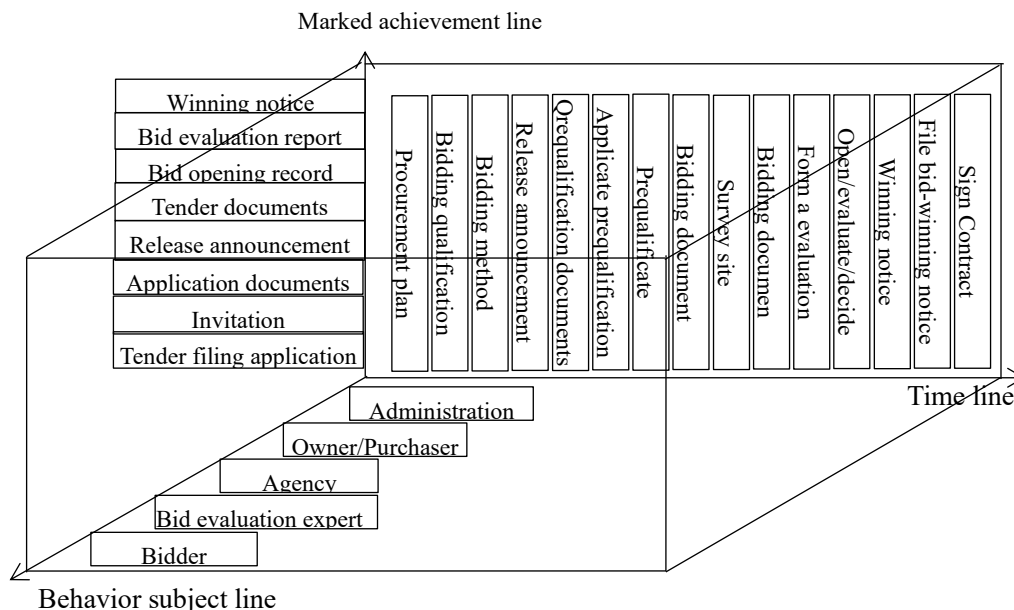


Fig 2. Three-dimensional structure model of bidding system operation.

Figure 2 depicts the operation structure of an "engineering bidding system". It will help teachers or students deepen teaching or understanding by choosing different knowledge planes or units according to professional features and employment needs. Subject line which describes all units of engineering management where students want to be employed after graduation. It can help students strengthen the knowledge required in corresponding work

according to the employment goals if the importance of strengthening the responsibilities of different actors in different stages of work and forming the results that involve their own interests is realized. Through the investigation, the teaching of bidding in engineering construction phase is generally paid attention to, but there are still deficiencies in placing bidding in the procurement strategy and management of enterprises, and the owners need to strengthen the procurement management. The three-dimensional structure can better visualize the knowledge system structure of "engineering bidding" and broaden students' cognition of bidding work.

4. Put the Problem Awareness and Thinking Method into Teaching Before - During - After Class

4.1 To set the problem in flipped classroom before class provides guidance for preview

In the traditional teaching mode, teachers hold forth on the platform, and students gain little in a class, which not only brings great challenges to teachers' teaching, but also fails to reach the expected effect. Flipped classroom is highly regarded as a new teaching mode. It changes the teaching mode from the "teaching-learning" mode to the "learning-teaching" mode, and readjusts the time distribution, as well as forms the process of pre-class knowledge transmission, in-class internalization and absorption, and after-class assistance and promotion. Before class, teachers design specific teaching links and put forward questions suitable for students' independent preview. Students learn independently by means of books, video, lectures and discussions. In the process of preview, students record learning difficulties and newly discovered problems. Then, teachers further prepare problems, discuss difficult points with students, and further deepen the practical significance of knowledge.

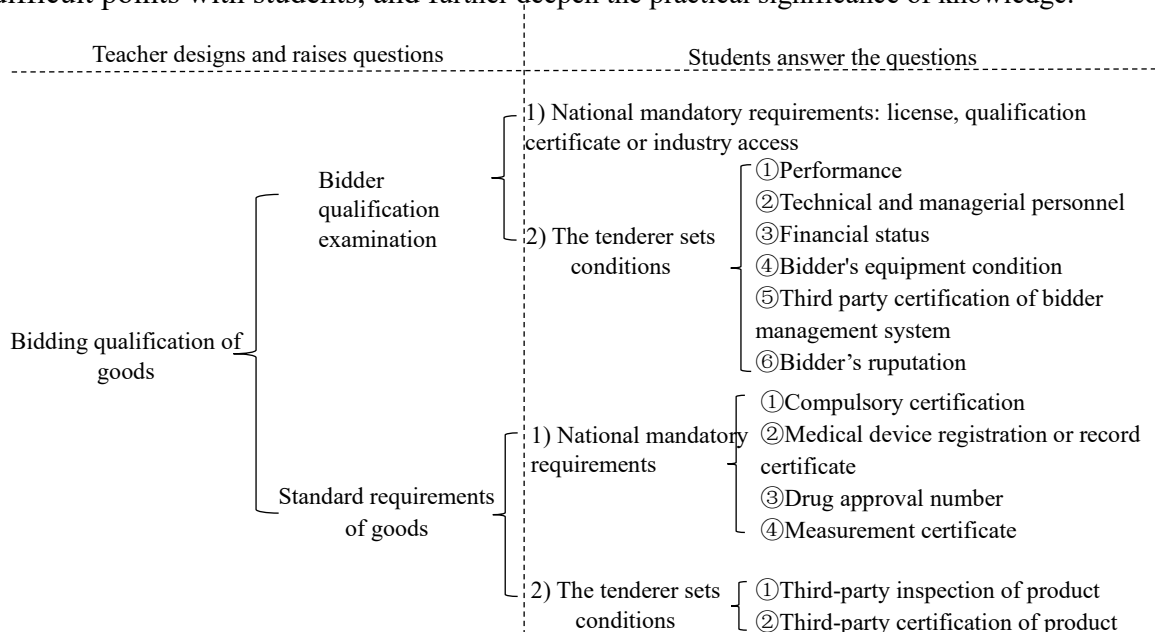


Fig.3 Problem design and mind map in flipped classroom.

Figure 3 shows the problem design and thinking logic map of the flipped teaching of the

process in goods bidding. First of all, teachers set problems according to the theme, and upload them to the network by recording small video before class. Then students use the internet to search for information or discuss to complete the preview independently. More time will be devoted to the discussion and solution of difficult problems in class. In addition, teachers can invite experts or lawyers to record video problem chain to enhance the professional setting of the problem chain. Inviting industry experts to record "flipped video" can not only save time, but also stimulate students' thinking and memory which improves their learning interest.

4.2 Teach step-by-step based on "stem"

The teaching materials of engineering bidding mainly rely on the description of knowledge system, and the course learning requires students to digest a lot of written contents, which often causes memory fatigue. Therefore, the application of knowledge reasoning logic should be emphasized. On the one hand, teachers should refine the multi-word knowledge system into knowledge modules. On the other hand, knowledge logic flowcharts need to make the process as dynamic as possible, while too simple or too complex will may not achieve the desired results. For a certain problem, the main process elements and influencing factors are firstly analyzed to identify the knowledge stem. Then the branch end of the knowledge stem is deduced.

Figure 4 shows a logical reasoning process of how to carry out the knowledge teaching of procurement staff motivation. The module in Figure 4 is the process given by the textbook, which constitutes the stem of this part of knowledge. The teacher conducts secondary logical reasoning in this "stem" knowledge framework. For example, teachers can guide students to talk about the understanding of the value of the reward and introduce their own career development of students "motivation" teaching through the procurement staff incentive teaching.

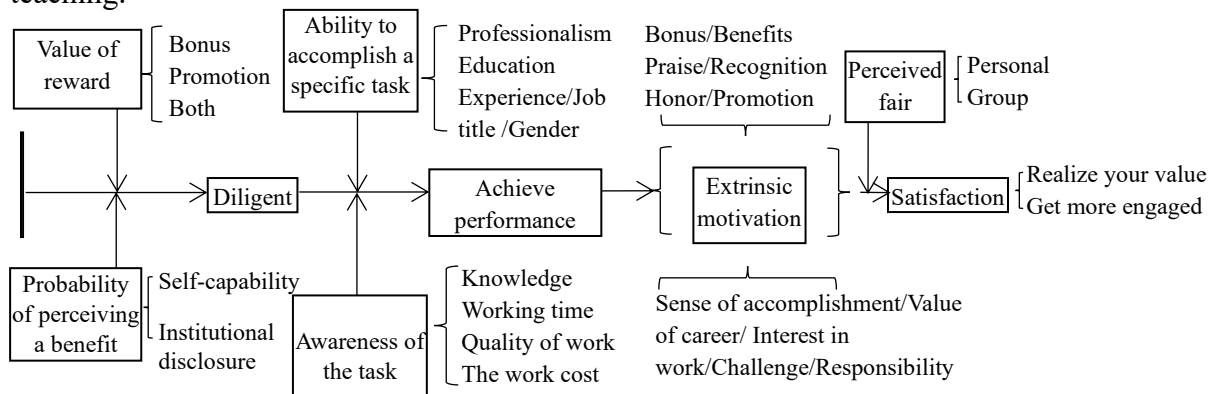


Fig. 4 "Stem - branch" combined reasoning for motivating purchasing staff.

Use 5W1H flexibly to summarize and understand specific problems after class

After class, internalization is an important stage in the learning process, which is related to whether the contents in class can be transformed into the ability of self-internalization. By the 5W1H method, students can better understand the essence of the problems by summarizing the knowledge from the perspectives of Why, What, Where, When, Who and How. Table 1 shows the application of a 5W1H in the bidding and procurement strategies.

First of all, it is clear what the specific problem is, that is, what kind of procurement strategy owners should adopt according to different market types and what are the basis and reasons of strategy segmentation.

Table 1. Problem mind map of 5W1H based on procurement strategy of market competition pattern.

5W1H	Fully competitive market	Fully monopolistic market	Monopolistic competitive	Oligopoly market	Buyer's market
Who-enterprise name	Conventional building materials	Cable company	Software operating system	Aircraft supplier	Single purchase and storage enterprise
Where-location	City or region	City	Global or national	Global or national	County with closed traffic
When- purchase occasion	Forecasting prices	Buy on demand	Buy on product	Consider the promotion	Consider the lead time
What-product name	Different type of steel bar or facing brick	Gas or cable	Microsoft vs. IOS	Telecom VS mobile	Sugar cane or beet
Why-reason	A large number of sellers, product homogeneity, complete information	National regulations	Large number of buyer and seller, product differentiation	Limited number of suppliers, small product differences	Rich supply, few or only storage companies
How- procurement strategy	Invitation to tender	Establish alliances, expand markets, and replace new technologies	Pay attention to the role of the brand	Competitive negotiation or invitation to tender or inquiry	Open tendering,

5. Conclusion

The integrated education model of problem chain and mind map can greatly motivate students' initiative and participation, and cultivate students' logical thinking mode and independent learning ability. In this paper, the engineering bidding course is taken as an example. The "problem chain" and the "mind map" are integrated to clarify the design method of the problem chain and the flexible application method of the "Hall Three-dimensional Structure" model in the knowledge system construction. Based on above methods, it further discussed how to use flipped classroom, logical reasoning, and 5W1H deepening problem chains with mind map methods before, during, and after class.

The teaching method integrated by "problem chain" and "mind map" provides students a systematic solution to the problem, and finally enables students to draw their own knowledge network of key points. This method can not only greatly improve the quality of teaching, and at the same time, it can also be applied to more similar courses to strengthen students' problem awareness, which is beneficial to the teaching of other courses in engineering management including engineering bidding courses.

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