

Research on the Application of Stem Teaching Concepts in the Teaching of Mathematical Modeling

Zhili Ge

(Nanjing Normal University of Special Education, Nanjing 210038, China)

Abstract: This paper mainly analyzes the application of Stem teaching concepts in mathematical modeling teaching. Including Stem teaching concept and its application in mathematical modeling teaching status, mathematical modeling teaching strategy based on Stem teaching concept, and the case analysis of crowdfunding house modeling based on Stem teaching concept. Through analysis, it is found that when teaching mathematical modeling based on Stem concepts, teachers should guide students to correctly understand mathematical modeling under Stem teaching concepts, so that they can play a leading role in learning, and improve the teaching quality by combining theory and practice. It is hoped that this analysis can provide some reference for the application of Stem teaching concept in mathematical modeling teaching.

Key words: Stem teaching concept; Mathematical modeling; Modeling teaching

In the present mathematical modeling teaching process, Stem teaching concept plays a vital application advantage. In order to improve the teaching quality of mathematical modeling and meet the actual learning and development needs of students, teachers should take Stem teaching concepts as the basis and adopt reasonable teaching strategies in specific teaching, so as to guide students to fully grasp enough mathematical modeling knowledge and improve students' practical ability by combining practical cases. In this way, Stem teaching concepts can be well applied and the quality of mathematical modeling teaching can be further improved.

1. Mathematical modeling teaching strategies based on Stem teaching concepts

1. Guide students to correctly understand mathematical modeling under the Stem teaching concept

In the process of mathematical modeling teaching based on Stem teaching concepts, one of the first teaching strategies is to guide students to have a correct understanding of mathematical modeling under Stem teaching concepts. In order to achieve this goal, teachers can infiltrate Stem teaching concepts into daily teaching, so that students can keep in touch with Stem teaching concepts imperceptively, and reasonably apply them to the details of mathematical modeling. Especially for some more abstract mathematical concepts, teachers should guide students to concretise them according to Stem teaching concepts through the integration of other subject knowledge, technology and mathematical models, so as to realize the scientific construction of mathematical models. At the same time, teachers can also introduce some life problems to enhance the interest of mathematical modeling teaching, and make students fully aware of the importance of mathematical modeling. This will be very beneficial to the integration of Stem teaching concept and mathematical modeling teaching and the improvement of teaching effect.

2. Give play to the leading position of students in learning

In the process of integrating Stem teaching concepts into mathematical modeling teaching, teachers must pay enough attention to the play of students' leading position, combine their actual characteristics and learning situation, and adopt reasonable strategies to implement modeling teaching. In order to achieve this goal, teachers can adopt the following strategies: 1) Introduce some hot issues related to the current teaching content of mathematical modeling into the teaching, so as to attract students' attention and make them more willing to actively participate in modeling learning. 2) Guide students to make clear the inner connection between mathematics and science, technology, engineering and art, so that they can master the skills of mathematical modeling through the integration of different disciplines, and promote students' learning enthusiasm through mathematical modeling competitions. 3) Introduce some common or interesting mathematical problems in daily life into modeling teaching, so as to create a life-like or attractive learning situation for students, so that they can better integrate into the life-like and interesting learning mode, in order to improve their learning effect.

3. Teaching through the combination of theory and practice

In the process of mathematical modeling teaching based on Stem teaching concepts, teachers teach through the strategy of combining theory and practice. In specific teaching, teachers can introduce actual engineering or project cases and guide students to reasonably establish mathematical models according to the actual profiles of related projects or projects. For more complicated and cumbersome problems, teachers should guide students to deal with them through information technology, and complete the construction of mathematical models in corresponding computer software, so as to achieve reasonable simplification of complex problems. At the same time, teachers should guide students to carry out mathematical modeling through information technology anytime and anywhere, and keep updating the information technology they have mastered according to the development of The Times.

2. Case analysis of crowdfunded house modeling based on Stem teaching concept

In the current Internet information age, crowdfunded house building has become a new form of development in the real estate industry. Therefore, in the mathematical modeling teaching based on Stem teaching concepts, teachers can introduce the most concerned crowdfunded house building projects and guide students to make mathematical modeling of them. The following is a case study of crowdfunded house building mathematical modeling teaching based on Stem teaching concepts.

1. Description of the problem

A crowdfunded housing project covers an area of 102077.6m². After the project was launched, tens of thousands of buyers registered to participate in the project. Participants are limited to one house per family. In the planning and design of housing construction, many factors such as floor area ratio, development cost, tax rate and expected income should be considered. In the original scheme design, according to the calculation method of various costs and value-added tax in the building, the designer gives the specific values of cost, income, floor area ratio and value-added tax. Among them, the cost is 2484163079.7000 yuan; The income is 590698016.8022 yuan, the plot ratio is 2.2852 yuan, and the VAT is 148313396 yuan. For this project, the main mathematical modeling requirements are to comprehensively calculate the original scheme through the establishment of mathematical models. The relevant data can be referred to the 2015 National College Students Mathematical Contest in Modeling D.

2. Model hypothesis and symbol description

For the crowdfunded housing project, in the specific mathematical modeling, the model assumptions mainly include the following three aspects: 1) The area proportion of all types of ordinary houses and non-ordinary houses is the same as that of known ordinary houses and non-ordinary houses. 2) The actual cost incurred in the object project is the same as the project development cost. 3) If the developer does not have the relevant certificate of financial institution, the real estate development fee is calculated at 10% of the cost fee.

In the specific modeling process, the main symbols used and their meanings are as follows: 1) r_j represents the floor area ratio; 2) j represents the total building area; 3) y represents the building land area; 4) c_b represents cost; 5) k stands for development cost; 6) g represents the amount of land purchase; 7) f represents development costs; 8) s represents taxes related to real estate transfer; 9) e represents other deductions; 10) z_s stands for value-added tax; 11) z represents value added; 12) k_c represents the amount of items deducted; 13) s_y represents earnings; 14) x_i represents i the number of type houses, of which 1,2,3,... 11; 15) m_i represents the customer's satisfaction with the housing; 16) a_i represents i the room area of the type house; 17) b_i development i cost of unit area of representative housing; 18) c_i representative i housing unit area income.

3. Model establishment

When teaching the mathematical modeling of this crowdfunded house building project, teachers should first guide students to fully understand the corresponding definitions of proper nouns and calculation formulas. In this modeling, the proper nouns involved include the following:

(1) Plot ratio: that is, the ratio of the total building area and the total land area within the scope of the project land. Therefore, in the specific calculation, its calculation formula is plot ratio = total building area/total land area, and its symbol calculation formula is:

$$r_j = \frac{j}{y} \quad (1)$$

$$\text{where } j = \sum_{i=1}^8 x_i a_i .$$

(2) Cost: that is, the total expenditure of the project, including the fees paid for the purchase of land use rights, land development expenses, land development expenses and taxes related to real estate transfer. The symbol calculation formula is as follows:

$$c_b = k + g + f + s \quad (2)$$

In this project, the fee g paid for the purchase of land use rights is 77,7179,627 yuan, and the land development expenditure k equals to the sum of the product of the area of various room types, the number of room types and the development expenditure of unit area. The symbol calculation formula of k is described as follows:

$$k = \sum_{i=1}^{11} x_i a_i b_i \quad (3)$$

(3) Real estate development expenses: namely, the expenses spent on land development, new houses and supporting facilities, including the management expenses, sales expenses and financial expenses related to real estate development projects. According to the current industry regulations, for the real estate that can not be calculated according to the public amortization of the real estate project, as well as the real estate that can not provide the relevant proof of financial institutions, the development costs are calculated and deducted according to the total amount of 10% of the expenditure in the process of obtaining the land use right and the real estate development costs. The symbol calculation formula is:

$$f = (g + k) \times 10\% \quad (4)$$

(4) The tax related to real estate transfer shall be controlled at 5.56% of the total project income according to the norms applied in this project. The symbol calculation formula is as follows:

$$s = \sum_{i=1}^{11} x_i a_i c_i \times 5.56\% \quad (5)$$

(5) Other deductions: For the relevant contents of this part, the taxpayer can deduct 20% of the sum of the expenses incurred when the land use right is obtained and the real estate development costs. The symbol calculation formula is as follows:

$$e = (g + k) \times 20\% \quad (6)$$

(6) Land value-added tax refers to a tax payable by the recipient or unit of value-added income after paid transfer of state-owned land use rights, buildings and other attached property rights on the transferred land. According to the Provisional Regulations of the People’s Republic of China on Land value added Tax, the land value added tax in China shall mainly be implemented in accordance with the progressive tax rate of four excess rates. Its main contents include the following points: First, if the value added does not exceed 50% of the total amount of the deducted items, its tax rate is calculated at 30%, at this time, land value-added tax is equal to the value added multiplied by 30%. Second, if the value added reaches more than 50% of the amount deducted, but does not exceed 100%, its tax rate is calculated at 40%, at this time, land value-added tax is equal to the value added multiplied by 40% minus the amount deducted by 5%. Third, if the value added reaches more than 100% of the amount deducted, but does not exceed 200%, the tax rate is calculated at 50%, in this case, the land value-added tax is equal to the value added multiplied by 50% minus the amount deducted by 15%. Fourth, if the value added reaches more than 200% of the amount deducted, the tax rate is calculated at 60%. In this case, the land value-added tax is equal to the value added multiplied by 60% minus the amount deducted by 35%. For ordinary standard houses built by taxpayers, when sold, if the value added does not exceed 20% of the deducted project amount, the land value-added tax can be exempted. The following is the symbolic formula for calculating the land value-added tax in the project:

$$z_s = \begin{cases} 0.3z \\ 0.4z - 0.05k_c \\ 0.5z - 0.15k_c \\ 0.6z - 0.35k_c \\ 0 \end{cases} \quad (7)$$

In order to find the value-added tax, it is first necessary to clarify the value-added tax and the deduction project fund, in which the deduction project fund is the sum of the cost and other project funds, and the value-added tax is the balance of the income obtained by the land value-added taxpayers from the transfer of real estate minus the specified deduction project amount. The symbol calculation formula is as follows:

$$z = s - k_c \quad (8)$$

In this project, revenue is defined as value added minus VAT, and its symbolic formula is as follows:

$$s_y = z - z_s \quad (9)$$

4. Model solving

During the modeling process, the competition data in the project was copied into excel for ease of calculation. The obtained data of value-added per unit area, VAT, deduction of project amount and income are shown in Table 1.

Table 1- Value added per unit area, VAT, deduction amount and income data obtained after modeling and calculation of this crowdfunded housing project

House Type	Value added per unit area	VAT per unit area	Deduct item amount per unit area	Income per unit area
1	34966.0153 yuan /m2	1,048.8046 yuan /m2	8503.9847 yuan /m2	2447.2107 yuan /m2
2	2,285.8153 yuan /m2	685.7446 yuan /m2	8514.1847 yuan /m2	1600.0707 yuan /m2
3	6,923.5153 yuan /m2	2,820.2,849 yuan /m2	4276.4847 yuan /m2	4103.2303 yuan /m2
4	2,918.3153 yuan /m2	875.4946 yuan /m2	9881.6847 yuan /m2	2,042.8207 yuan /m2
5	2,944.3153 yuan /m2	883.2946 yuan /m2	9855.6847 yuan /m2	2,061.0207 yuan /m2
6	3354.6153 yuan /m2	1006.3846 yuan /m2	10,245.3847 yuan /m2	2,348.2,307 yuan /m2
7	3534.4153 yuan /m2	1060.3246 yuan /m2	10,465.5847 yuan /m2	2,474.0907 yuan /m2
8	6,231.4153 yuan /m2	2490.4199 yuan /m2	4168.5847 yuan /m2	3,740.9953 yuan /m2
9	292.4153 yuan /m2	65.5303 yuan /m2	6107.5847 yuan /m2	226.8850 yuan /m2
10	503.4153 yuan /m2	112.8154 yuan /m2	6296.5847 yuan /m2	390.5999 yuan /m2
11	3,614.5153 yuan /m2	1,269.4349 yuan /m2	3,585.4847 yuan /m2	2,345.0803 yuan /m2

Closing Remarks:

To sum up, Stem teaching concepts are very applicable in the teaching of mathematical modeling. Based on this, in the specific mathematical modeling teaching, teachers should take the Stem teaching concept as the basis and carry out teaching through reasonable strategies. Only in this way can the actual modeling teaching needs be fully met and the quality of mathematical modeling teaching be improved.

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About the author: Ge Zhili, female, doctor, born in November 1983, Associate professor, School of Mathematics and Information Science, Nanjing Normal University of Special Education, Research interests: Operations Research and cybernetics. Project Fund: This work was supported by the National Natural Science Foundation of China (Grant No.12001281) and Qing Lan Project.