A Practical Research on Mathematics Teaching in Secondary Vocational Schools by Integrating Mathematical Modeling

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Abstract: Applied mathematics matters importantly in secondary vocational education. By integrating mathematical modeling, a kind of applied mathematics, as well as the theory and practice of modeling idea, this paper puts forward relevant teaching methods.

1. Introduction

As a major compulsory course in secondary vocational schools, mathematics poses influences on students' professional knowledge learning, especially on engineering students. Basing on the trend of educational reform and following the reform of mathematics education in secondary vocational schools, this paper combines theory and practice to explore the practical activities of mathematics teaching in secondary vocational schools by integrating with mathematical modeling.

2. Exploring mathematics modeling

1) Mathematical modeling is the overall process of establishing a mathematical model by explaining actual problems through the results of calculations and accepting the actual test. The most important idea of mathematical modeling is how to abstract practical problems into mathematical models.

2) The relationship between mathematical modeling and mathematics teaching. The essence of mathematical modeling is mathematics applying, which is also the ultimate goal of mathematics teaching.

3)The necessity of integrating mathematical modeling into mathematics education in secondary vocational schools to solve social phenomena such as engineering technology, prediction and decision-making, optimized scheme, etc. Mathematical theory is sure to be used. Mathematical modeling idea is to train students' ability of thinking and problem solving, so it must be integrated into secondary vocational mathematics education.

3. Increasing the Application of Mathematical Modeling in Case Teaching

The best way to apply mathematical modeling is to combine practical cases. As for teaching design, provided teachers are good at studying textbooks, then they can construct good cases with rich connotation and practical significance by combining mathematical knowledge with life and production practice, we can. For instance, when the author are explaining the application of the standard equation of straight line and circle, by combining the training task of NC (numerical control) machining "automobile model", the author extracts a local contour map of automobile (shown in fig.1), which needs to get the coordinates of O, B, C and D. Among them, point B is the smooth connection point between straight line and arc. Students are required to use the knowledge of straight line and circle to find the coordinates of point B.

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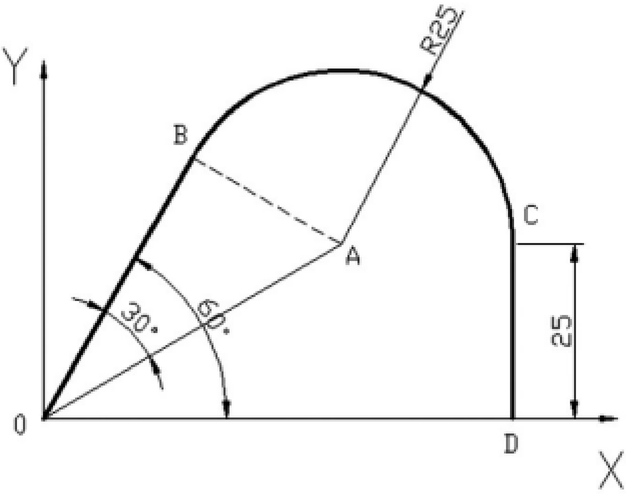

Fig.1 Local contour of an automobile model

Model analysis: By cooperating, communicating and discussing, students found that the coordinates of O, C and D are easy to find after the establishing a proper plane rectangular coordinate system. The difficulty lies in how to find the coordinates of B. Point B is regarded as the smooth connection point of line and circle A where OB is located. Model simplification: According to the diagram, after finding the equation of straight line and circle, and the equation of straight line and circle can be solved. Model establishing and solution: The oblique angle of the straight line OB is 60°, $k_{OB}=\tan 60°=\sqrt{3}$ (through the origin), the linear equation is $y=\sqrt{3}x$; Set the center of the circle $A(x_A,y_A)$, and set the vertical line of x through A, forming the intersection point E (see fig.2).

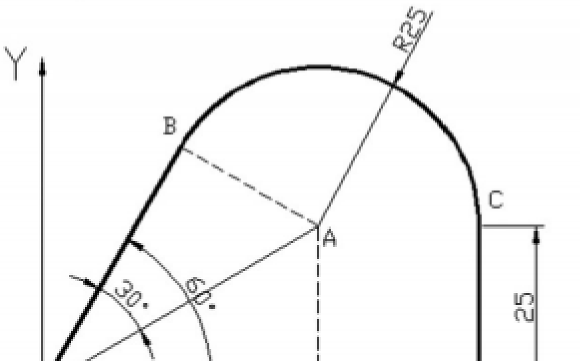

Fig.2: Local contour of the car model after setting the auxiliary line

If RT $\Delta OBA \cong$ RT ΔOEA,then $x_A=OE=25\sqrt{3}$, $y_A=AE=25, r_A=25$,and the standard equation of circle is $(x-25\sqrt{3})^2+(y-25)^2=25^2$。By combining linear equation and circular equation:

$$\begin{cases} y=\sqrt{3}x \\ (x-25\sqrt{3})^2+(y-25)^2=25^2 \end{cases}$$

We can get

$$\begin{cases} x = \dfrac{25\sqrt{3}}{2} \\ y = \dfrac{75}{2} \end{cases}$$

Hence the coordinates of point B are:$(\dfrac{25\sqrt{3}}{2}, \dfrac{75}{2})$

By abstraction, simplification, modeling and solving, students can know the use and benefits of the knowledge they have learned, and their thirst for knowledge can be boosted. Then teachers can properly introduce a new concept or application of new knowledge into the teaching of professional courses.

It is necessary to guide students to use calculators or mathematical software to reduce the burden of calculation, in a bid to concentrate on training students in mathematical modeling thinking. For example: model simplification: we can know which group is better in a game, the scorers of two groups of scorers record the results of the game, as shown in Table 1.

Table 1 The scores of A and B groups in a dart match

A	8	5	7	9	8	10	9	8	7	6	8	4	9	3	7	10	8	9
B	6	9	8	10	7	6	9	3	9	10	9	6	8	9	9	8	5	4

Model building: Firstly, the average values of dart scores of A and B groups are calculated. At this time, students can use calculators or the results recorded by scorers, and input the scores directly into EXCEL, then use “AVERAGE” function to calculate the average values.

$\overline{X}_A$=7.5, $\overline{X}_B$=7.5. Then the variance of two groups can be calculated directly by combining calculator with variance calculation formula, or by using the "VAR" function in EXCEL spreadsheet, S_A^2 = 3.79, S_B^2 = 4.26. Model solution: Based on $\overline{X}_A$=7.5, $\overline{X}_B$=7.5, the average level of A and B is equal; Based on S_A^2=3.79, S_B^2=4.26, we can see $S_A^2 < S_B^2$, that is, the performance of group A is more stable than that of group B.

Teaching Model in Inquiry Learning of Mathematics in Secondary Vocational Schools

The process of mathematical modeling is actually a process of cultivating students’ awareness to use mathematical, which is in line with the direction of mathematics teaching reform in secondary vocational schools. Case study: Gear selection of variable-speed bicycles.

(1) Background

Many people in China use bicycles as their basic means of transportation, and many ride variable-speed bicycles, such as mountain bikes and racing cars. A bicycle may have “10 speed”, “12 speed” or even “18 speed”.

(2) To raise questions by grouping discussion

Which gear is better for climbing? We investigate and study them therefore.

(3) Model hypothesis and data measurement

First of all, we should make clear how bicycle work, then a 10-speed 26-type mountain bike of "Giant" brand in good condition is selected as the research object. Table 1 is obtained after measuring (in this paper the number of similar gears ranges from large to small if there is no specific explanation).

Table 2

<table>
<tr><th>Item</th><th>Data</th><th>Item</th><th>Data</th></tr>
<tr><td rowspan="2">Diameter D of rear wheel (inch)</td><td rowspan="2">26</td><td>The number of sprocket wheel</td><td>2</td></tr>
<tr><td rowspan="2">The number of teeth on the sprocket wheel</td><td>48</td></tr>
<tr><td>The number of fly wheels</td><td>5</td><td>40</td></tr>
<tr><td rowspan="5">The number of teeth on the fly wheels</td><td>28</td><td rowspan="2">The radius of sprocket wheel Rn(cm)</td><td>9.83</td></tr>
<tr><td>24</td><td>8.19</td></tr>
<tr><td>20</td><td rowspan="5">The radius of fly wheel r_n(cm)</td><td>5.73</td></tr>
<tr><td>17</td><td>4.91</td></tr>
<tr><td>14</td><td>4.10</td></tr>
<tr><td>Net weight of the bike(kg)</td><td>18</td><td>3.48</td></tr>
<tr><td>The length of crack(cm)</td><td>18</td><td>2.86</td></tr>
</table>

(4) Model establishment and solution

1) Flat Road

①Speed, set Kmn = Nm/Nn. ①the ratio of the number of teeth in the front and rear wheel, with the wheel turning one cycle For the same speed-variable vehicle, we can think that km is the only factor to change the speed, which is temporarily called the speed coefficient, then the speed of the bicycle is $v_{mn}=k_{mn}Cf$. (C is the circumference of the wheel and f is the frequency of the bicycle).

From the above data, we can get

$$C=\pi\times 26\text{inch}\times 2.54\text{cm/inch}=207\text{cm}=2.07\text{m}$$

Generally, if we set f=1circle/s=3600circle/h,

Then the velocity coefficient and velocity under different gear ratios can be calculated, as shown in the following table:

Table 3

v(km/h)	N1=48		N2=40	
q1=28	K11=1.71	V11=12.8	k21=1.43	v21=10.66
q2=24	K12=2	V12=14.94	k22=1.67	v22=12.45
q3=20	K13=2.4	V13=17.93	k23=2	v23=14.94
q4=17	K14=2.82	v14=21.35	k24=2.35	v24=17.58
q5=14	K15=3.43	v15=25.62	k25=2.86	v25=21.34

②Work consumed

We find that the dynamic friction coefficient between rubber and dry ground is 0.71, and if the resistance is Z, the negative force of wheels in motion is $Z=(m_{people}+m_{bike})g\times 0.71$

m_{people} stands for a person's mass, m_{bike} stands for the net weight of a bike, g is gravity acceleration, $g=9.8/s^2$

If a student has 65kg of weight, and the resistance is

$$Z=(65+18)\times 9.8\times 0.71=577.514N$$

The mechanical system consisting of a rear wheel and a flywheel can be regarded as a wheel axle. Therefore, Z×D/2=rnZn, in which Zn flywheel needs a force, and the chain also functions as force transmission in the whole transmission process, so the force on the sprocket is also Zn. Because the sprocket and crank form a wheel axle, and thus Zn×Rm=Fnm×Lmn. ⑤in which L is the crank length and Fmn is the force by people. The results are as follows:

Table 4 (unit: N)

Z_1	Z_2	Z_3	Z_4	Z_5
3328.01	3883.81	4651.1	5479.74	6667.67

Table 5 (unit: N)

Fmn	R1	R2
Z_1	1817.46	1514.24
Z_2	2120.99	1767.13
Z_3	2540.02	2116.25
Z_4	2992.55	2493.28
Z_5	3641.29	3033.79

If the vehicle runs lkm, then Pmn=Fmn×lkm, in which Pmn is the work. In order to find a gear which can save labor and obtain higher speed, the smaller value is the required gear.

After calculation, the following results are obtained:

Table 6

Gear	K11	K12	K13	K14	K15
Work(J)	1817.46	2120.99	2540.02	2992.55	3641.29
Speed	12.8	14.94	17.93	21.09	25.62
Work/Speed	141.99	141.96	141.66	141.89	142.13
Gear	K21	k22	k23	k24	k25
Work(J)	1514.24	1767.13	2116.25	2493.28	3033.79
Speed	10.66	12.45	14.94	17.58	21.34
Work/Speed	142.05	141.94	141.65	142.82	141.16

We can be seen from the above table, using k13 and k23 gears can achieve relatively high speed by consuming less work. k23 is slightly better in these two gears. But it cannot be felt in a short distance because of small difference.

2) Climbing

We will climb a slope with an angle of 15°. The length of the slope is l km, other conditions are the same with the those of flat road. It can be calculated by $Z=(m_{people}+m_{bike})g\times 0.71\times\cos+(m_{people}+m_{bike})g\times\sin$, Z=768.36(N), speed and force required in climbing, as shown in Table 7:

Table 7

Fmn	R1	R2
Z_1	2418.07	2014.64
Z_2	2821.90	2351.18
Z_3	3379.40	2815.59
Z_4	3981.47	3317.22
Z_5	4844.59	4022.27

Only the gears whose work is below 3000 are studied, and the amount of work per unit speed is required to get the following data.

Table 8

Gear	K11	K12	K21	K22	K23
Work(J)	2418.17	2821.9	2014.64	2315.1	2815.59
Speed	12.8	14.94	10.66	12.45	14.94
Work/Speed	188.91	188.88	188.99	188.84	188.46

From the above table, we can conclude using k21gear when climbing the slope can achieve greater speed and reduce power consumption, and in fact this gear is still more effective in the five gears. Therefore, you can use k11 to save labor.

(5) Analysis and conclusion of the model

To sum up, we can finally draw three conclusions through investigation, analysis and calculation:

a. When riding on flat ground, sprockets and 20-tooth flywheels are used to save labor and speed.

b. When climbing a slope, using a smaller sprocket and a 20-tooth flywheel is actually labor-saving.

c. Through the above data, we can also find that the “10-speed” variable bike can only achieve nine speeds, among which some are so close that we cannot even feel the difference, and thus it is not the more speeds the better.

4. Conclusion

Applied mathematics matters importantly in secondary vocational education. By integrating mathematical modeling, a kind of applied mathematics, as well as the theory and practice of modeling idea, this paper puts forward relevant teaching methods.

References

[1] Gu Zhiyuan. Exploration and Practice of Mathematics Teaching Reform in Higher Vocational Education Based on Mathematical Modeling [J]. Journal of Southern Vocational Education, 2014, 4 (02): 17-21.

[2] Zhang Haiyan. Application of Mathematical Modeling in Mathematics Teaching in Elementary School [J]. Modern Education, 2015 (10): 88.

[3] Zhang Xuexin. Research and Practice of Integrating Mathematical Modeling Idea & Method into Classroom Teaching of Mathematical Statistics[J]. Journal of Xinjiang Normal University (Natural Science Edition), 2016,35(01): 63-71+2.

[4] Zhao Rui, Cao Jing. Integrating Mathematical Modeling into Engineering Mathematics Teaching [J]. Education and Vocation, 2016 (10): 119-120.

[5] Wang Zhiqi. Exploring the Application of Mathematical Modeling in Mathematics Teaching[J]. Journal of Inner Mongolia Normal University (Educational Science Edition), 2013, 26 (06): 141-143.