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Advanced mathematics curriculum system's mathematical model establishment and application

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ABSTRACT

Mathematical modeling is an important path to apply basic mathematics into each discipline field; convert abstract mathematical knowledge into practical and interesting mathematical model is difficulty of advanced mathematical course. The paper according to mathematical modeling attributes and effects, combines with advanced mathematics curriculum knowledge system contents, explores methods and countermeasures that fuse mathematical model and advanced mathematical system. By analytic hierarchy process method, the paper gets important conclusions. At last, the paper's author provides advanced mathematics curriculum system's triple integral knowledge mathematical model establishment and application.

KEYWORDS

Mathematical modeling; Curriculum system; Triple integral; Reformation path.

INTRODUCTION

In the end of last century, mathematical modeling was introduced from America to Chinese universities classroom. Since 1992, every year has held a national universities mathematical modeling contest. During just twenty and thirty decades, mathematical modeling has been rapidly developed and grown through the form of contest, and brought new orientations to universities mathematics teaching reformation. Mathematical modeling is the bridge that connects abstract mathematics with objective world, nowadays mathematics goes deeper into every field with unprecedented scope, problems researches cannot do without establishing mathematical models. In universities mathematical courses, it is advanced mathematics teaching-based, mathematical models establishment and application in advanced mathematics curriculum system is crucial to cultivate students' innovation and problems solving abilities.

For mathematical modeling and universities mathematical system reformation path researches, formers have gone through countless trials and efforts. Among them, Jiang Qi-Yuan, Xie Jin-Xing researched on mathematical modeling effects on education and teaching reformation by analyzing mathematics modeling teaching and contest development. Zhang Hai-Yan made researches and thought that mathematical modeling had important effects on cultivating applied undergraduate talents, and suggested to fuse mathematical modeling thoughts into relative curriculum system teaching. Qin Si-Yi, Xu Quan-Zhi, Du Hong-Fei, Huang Ting-Zhu researched on practice of fusing mathematical modeling thought into universities basic disciplines, and made effective combination among mathematical modeling and probability theory as well as mathematical statistics course, took a giant step forward practice. Wang You-Guo carried on research and analysis of universities mathematical curriculum system reformation, in reformation, it got involved in mathematical modeling and mathematical curriculum system fusion, and got some phased objectives.

On the basis of formers research, the paper combines with mathematical modeling features and universities mathematical reformation targets to make researches and analysis of universities advanced mathematics curriculum system's mathematical modeling establishment and application, focuses on analyzing mathematical model's establishment and application values and effects, as well as notes and practical methods during mathematical models establishment in advanced mathematics curriculum system.

MATHEMATICAL MODELING

Popular to say, mathematical modeling is a mathematical process that applies mathematics to establish and solve practical problems. Mathematical model establishment makes concrete application of mathematics into practical problems; mathematical modeling mainly can divide into two main types, mechanism research analysis and test and prediction analysis. The former has relative clear actual significance, and the later mainly is researching blackbody model's mathematical problems that are complex and not yet find mechanism.

Mathematical modeling effects

Mathematical modeling has developed and grown in just decades, which surely have its developing ideas. What are effects of mathematical modeling to students' cultivation and mathematical development, why it is favored by extensive universities and students? Main reasons are as following.

Firstly mathematical modeling has brought dynamism to universities mathematical education reformation, reform mathematics education through mathematical modeling is an effective path. Mathematical modeling has converted mathematical abstraction into practical problems; it greatly arouses students' learning initiatives. And meanwhile it promotes students' abilities in innovation, problems solving, teamwork aspects, and also builds foundation for researching on undergraduate. It can

also cultivate students' credit consciousness and self-discipline spirits. For faculty, mathematical modeling also promotes mathematical faculty team development and construction; it brings opportunity to teachers' growth. In addition, mathematical modeling attracts attentions of all sectors of society, it generates good impacts.

Mathematical modeling development

Mathematical modeling, since formed in China, was rapidly developing after short time fermenting. In 2011, national universities mathematical modeling contests involved universities arrived at 1251pieces, and participation teams are 19490, thousand of universities set up different types of mathematical modeling courses, and even lots of universities tried to explore mathematical modeling and universities mathematics curriculum system fusion. According to national universities student modeling websites provided data, it indicates that mathematical modeling contests domestic development speed is amazing. Data statistics sketch from year 1994 to 2008 is as following.

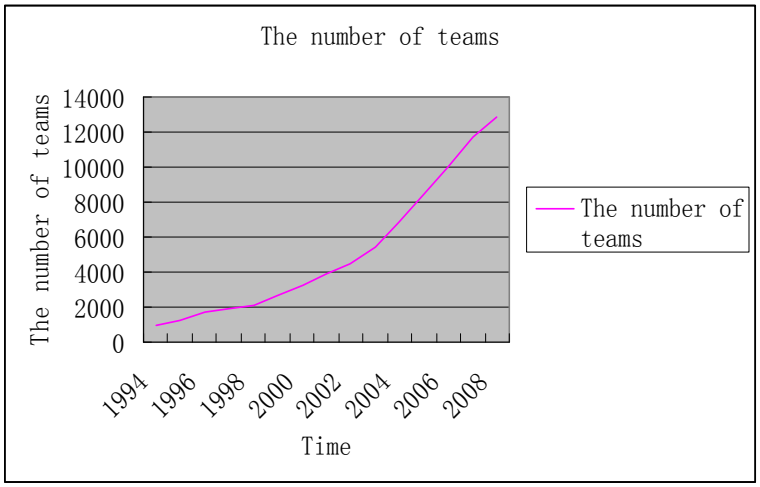

Figure 1 : Participation teams amount growth curve

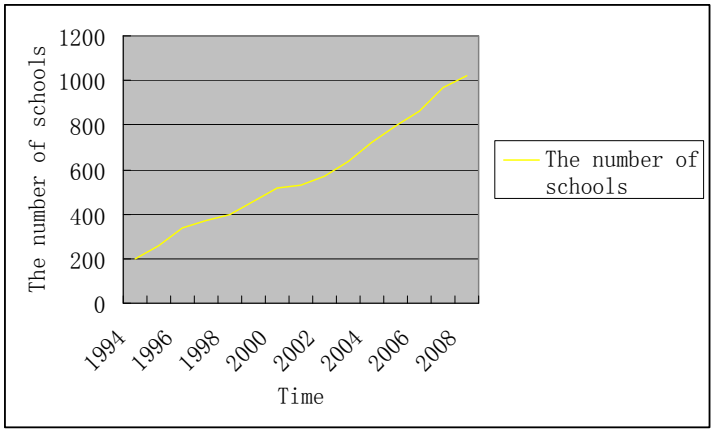

Figure 2 : Participation schools growth curve

From Figure 1, it is clear that since number of participation teams from year 94 to 08 has rapidly ascended from previously less than 1000 to nearly 13000, it increases nearly 13 times. It presents non-linear rapidly growth. It is clear that mathematical modeling contest in universities are very popular, and more and more students participate in them. In Figure 2, it shows number of universities (including vocational schools) that organize and participate in mathematical modeling contests is nearly in linear

growth, recent years are rapid development periods of mathematical modeling contests. Universities recognition on mathematical modeling can be affirmed, universities emphasis on mathematical modeling promotes mathematical modeling development.

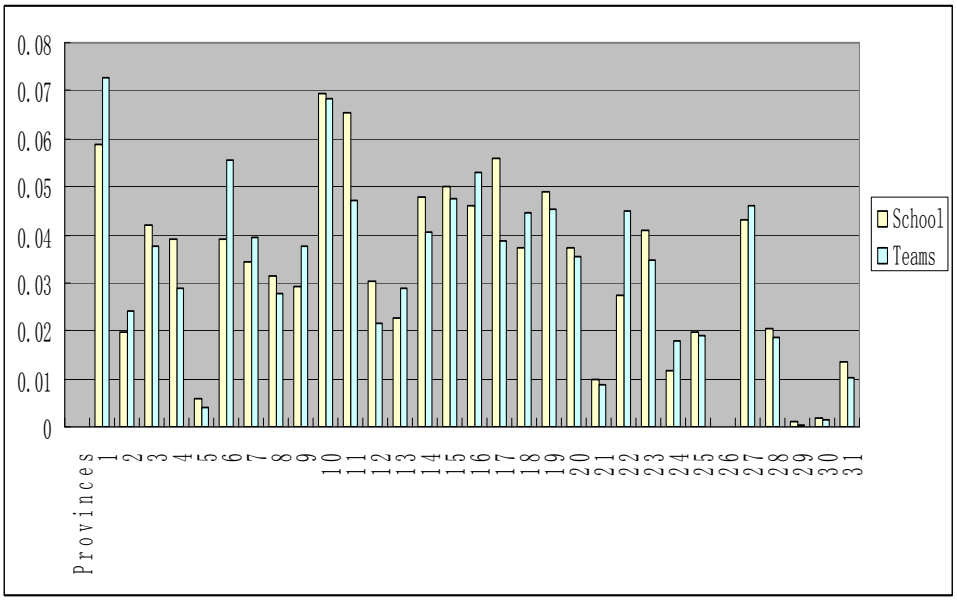

Figure 3 : Each province (direct-controlled municipality) participation universities and teams proportion bar chart

In Figure 3, horizontal axis numbers successively represents regions as Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shanxi, Gansu, Qinghai, Ningxia, Xinjiang. Figure is drawn according to year 2008 mathematical modeling contest data, in participation schools proportions, Jiangsu and Zhejiang respectively occupy above 6% of total number of schools that belong to maximum provinces of participation schools. Beijing is maximal in participation teams' proportion that arrives at 7.26% of totality, secondly is Jiangsu province that is 6.87%. With fewer provinces exception, overall provinces and cities' number of schools and teams that participate in mathematical modeling contests are very big, it shows whole universities are striving to mathematical modeling teaching.

MATHEMATICAL MODELING AND ADVANCED MATHEMATICS CURRICULUM SYSTEM

In advanced mathematics curriculum system's mathematical models establishment and application should adhere to following criterions:1, arouse students interests in mathematics, model examples can be understood and willing to research by everyone. 2, Model should have practical significances, let abstract mathematics to be vivid.3, Grasp advanced mathematical knowledge and modeling commonalities, super class or go beyond students' mathematical ability or receptivity will frustrate students' self-confidence and interests.4, Mathematical model has simplicity, openness, creativity, excessive complicated mathematical models in advanced mathematics curriculum system has no sufficient time to illustrate, and complicated and diverse mathematical models are hard to be understood by students, openness refers to students can solve problems by imagination as much as they like, creativity refers to students can promote innovation capacity from them.

Advanced mathematical curriculum system's mathematical model's establishment and application can carry out from following aspects. 1, Cultivate mathematical modeling faculty team, only

faculty has ability in modeling then can freely create mathematical models in class as much as he likes and attract students attention. 2, Penetrate modeling thoughts in advanced mathematics teaching, in the beginning, it doesn't need to establish mathematical models, firstly let modeling thought to drive students to think, go deeper and make progress step by step.3, Change advanced mathematics teaching system contents proportions, add mathematical modeling class hours and contents in basic advanced mathematical knowledge contents. 4, Establish curriculum system's mathematical model experience base, for one chapter and section's formers made advanced system domain mathematical model's teaching examples, it should record and save so as to be convenient for posterity learning, teaching. Therefore establish advanced mathematical curriculum system and mathematical models and establish corresponding hierarchical structural TABLE 1.

TABLE 1 : Hierarchical structural table

Target	Criterion (C)	Scheme (P)
Advanced mathematics curriculum's mathematical models establishment and application	Arouse students' interests	Cultivate faculty team
	Advanced mathematics and models' commonalities	Course penetrates into modeling thought
	Model has practical significances	Add curriculum modeling contents
	Model's simplicity, openness, creativity	Accumulate mathematical models' Experiences

Discuss about criterion layer and scheme layer weight

According to analytic hierarchy process, it calculates criterion layer weights, firstly constructs judgment matrix. By criterion conditions paired mutual comparison, calculation results use 1-9 or their reciprocals to express. C_i, C_j importance comparison structure is using a_{ij} to express, then all factors carry out comparison and then can get judgment matrix A. Its expression is as following.

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{ij} \end{pmatrix}$$

Among them, number respective expressive definitions are as following TABLE 2.

TABLE 2 : 1~9 scale meaning

Scale	Meaning
1	Indicates two factors have equal importance by comparing
3	Indicates the former is slightly more important than the later by comparing two factors
5	Indicates the former is more important than the later by comparing two factors
7	Indicates the former is relative more important than the later by comparing two factors
9	Indicates the former is extremely more important than the later by comparing two factors
Even number	Represents importance is between two odd numbers
Reciprocal	Represents factors positive and negative comparison orders.

Weight vector and maximum feature value to calculate weights that meet:

$$w_1 + w_2 + w_3 \cdots + w_n = 1$$

Compare n pieces of factors, and get consistency matrix:

$$A=\begin{pmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{pmatrix}$$

Firstly make normalization on all column vectors of A and get matrix D

$$D=\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \bullet \begin{pmatrix} 1/\sum_{i=1}^{n} a_{i1} & 0 & \cdots & 0 \\ 0 & 1/\sum_{i=1}^{n} a_{i2} & \cdots & 0 \\ 0 & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1/\sum_{i=1}^{n} a_{in} \end{pmatrix}$$

Solve obtained matrix every line sum:

$$E=D\bullet\begin{pmatrix}1 & 1 & \cdots & 1\end{pmatrix}_{1\times n}^{T}$$

$$E=\begin{pmatrix}e_{11} & e_{12} & \cdots & e_{1n}\end{pmatrix}^{T}$$

Normalize matrix E that is weight vector:

$$W=\begin{pmatrix}w_1 & w_2 & \cdots & w_n\end{pmatrix}^{T}=\begin{pmatrix} e_{11}/\sum_{i=1}^{n} e_{i1} & e_{12}/\sum_{i=1}^{n} e_{i1} & \cdots & e_{1n}/\sum_{i=1}^{n} e_{i1} \end{pmatrix}^{T}$$

Calculate maximum feature value, weight vector corresponds to maximum feature value, then it surely has:

$$AW=\lambda_{\max}W$$

$$\lambda_{\max}=\frac{1}{n}\sum_{i=1}^{n}\frac{(AW)_i}{w_i}$$

Consistency test, CI represents matrix consistency indicator, CR represents matrix consistency rate, test matrix consistency by the two indicators calculation.

$$CI=\frac{\lambda_{\max}-n}{n-1}$$

Among them, n represents judgment matrix one layer number of factors, and meanwhile the order of matrix.

$$CR = \frac{CI}{RI}$$

Among them, RI represents Random Consistency Index value, as following TABLE 3 show.

TABLE 3 : RI value table

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

In criterion layer, factors weight is α_m, scheme corresponding factor weight in scheme layer is β_{nm}, then scheme weight in scheme layer is:

$$w_i = \sum_{j=1}^{m} \alpha_i \beta_{ij}$$

Consistency ratio is:

$$CR = \frac{\sum_{j=1}^{m} \alpha_j CI_j}{\sum_{j=1}^{m} \alpha_j RI_j}$$

When $CR \geq 0.1$, matrix inconsistency cannot accept. When $CR < 0.1$, matrix inconsistency can accept

Criterion layer and scheme layer weight calculation result

Construct judgment matrix and calculate criterion weight and matrix consistency test indicators. Result is as following:

	C_1	C_2	C_3	C_4	W	CR
C_1	1	2	2	1	0.332	0.03
C_2	1/2	1	2	1	0.235	
C_3	1/2	1/2	1	1/3	0.126	
C_4	1	1	3	1	0.308	

By above table calculation result, it can get $CR < 0.1$, so matrix passes test. Result indicates arouse students' interests weight is the largest, secondly are respectively, model's simplicity, openness, creativity and advanced mathematics commonalities, model has practical significances. Therefore, in advanced mathematics curriculum system, mathematical model establishment should lay particular emphasis on arousing students' interests and model itself attributes, model practical significance doesn't take important roles, only need model to arouse students' initiatives in mathematics learning without breaking away from students imaginations.

Scheme layer corresponding criterions layer every criterion weight calculation results.

C_1	P_1	P_2	P_3	P_4	W	CR
P_1	1	3	5	2	0.466	0.011

P_2	1/3	1	2	1/2	0.161	
P_4	1/5	1/2	1	1/3	0.096	
P_5	1/2	2	3	1	0.277	

C_2	P_1	P_2	P_3	P_4	W	CR
P_1	1	2	1/3	1/2	0.158	0.005
P_2	1/2	1	1/5	1/3	0.088	
P_3	3	5	1	2	0.482	
P_4	2	3	1/2	1	0.272	
C_3	P_1	P_2	P_3	P_4	W	CR
P_1	1	1/2	3	2	0.272	0.005
P_2	2	1	5	3	0.482	
P_3	1/3	1/5	1	1/2	0.088	
P_4	1/2	1/3	2	1	0.158	

C_4	P_1	P_2	P_3	P_4	W	CR
P_1	1	3	1/2	2	0.267	0.004
P_2	1/3	1	1/6	1/2	0.083	
P_3	2	6	1	3	0.496	
P_4	1/2	2	1/3	1	0.154	

Every judgment matrix test value $CR < 0.1$, and combination consistency test value $CR < 0.1$. Therefore, analytic hierarchy process judgment matrix consistence conforms to calculation requirements. Relative data is as TABLE 4 and TABLE 5.

TABLE 4 : Scheme weight calculation result summary

Scheme weight arrangement	C_1	C_2	C_3	C_4	Total arrangement
	0.332	**0.235**	**0.126**	**0.308**	**Weight**
P_1	0.466	0.158	0.272	0.267	0.3280
P_2	0.161	0.088	0.482	0.083	0.2577
P_3	0.096	0.482	0.088	0.496	0.1505
P_4	0.277	0.272	0.158	0.154	0.2638

TABLE 5 : Criterion and scheme layer weight table

Criterion（C）	Weight	Scheme（P）	Weight
Arouse students' interests	0.332	Cultivate faculty team	0.3280
Advanced mathematics and models' commonalities	0.235	Course penetrates into modeling thought	0.2577
Model has practical significances	0.126	Add curriculum modeling contents	0.1505
Model's simplicity, openness, creativity	0.308	Accumulate mathematical models' experiences	0.2638

CONCLUSION

In advanced mathematics curriculum system, mathematical model establishment and application firstly should cultivate faculty team with mathematical modeling thought, secondly is referencing and accumulating advanced mathematics curriculum system's mathematical model's experiences. The two schemes belong to early period preparation are crucial. Secondly is penetrating mathematical modeling thoughts into courses and further adding advanced mathematical curriculum system's mathematical modeling contents so as easy to students understand and accept.

In advanced mathematics curriculum, established and applied mathematical models should meet mathematical models can arouse students interests, have simplicity, openness, and creativity. Fuse mathematical modeling into advanced mathematics curriculum system is a kind of groping way, it needs to continue to try, combine with advanced mathematics knowledge and contents establish and apply corresponding mathematical model are premise that students can use knowledge to accept mathematics. Such as in advanced mathematics triple integral, it can establish mathematical model to use to solve volume so that avoids dullness. The paper establishes available following models. Students used cup, appearance of cup shows regular shapes (straight or arc) then how to establish mathematical model to calculate cup different positions' water capacity. Model's simplicity and connection with life have practical significances; it can arouse students' exploration and thinking.

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