A Study on the Framework of College Curriculum Reform through Mathematical Modelling Based on Markov Linear Modelling

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Abstract

It is the ultimate goal of college education in our country to cultivate the comprehensive quality of college students, which requires affirming criteria for comprehensive quality education and avoiding differences among students themselves. This paper suggests establishing a mathematical evaluation model to offer references for teaching content update, analyses relations among comprehensive quality education variables and sets evaluation criteria and direction with the help of homogeneous Markov Linear Mathematical Modelling. This paper aims at offering theoretical references for college comprehensive quality education by perfecting its evaluation model with a mathematical model.

Keywords: Mathematical Modelling, Teaching System, Comprehensive Quality.

1. RESEARCH BACKGROUND

1.1 Literature review

The goal of modern education is to cultivate the comprehensive quality of students, namely, a combination of practical ability and technical skills, which are also the specific requirements for compound talents and practical talents (Wang and Jiang, 2016). However, as far as the performance of students in social practice is concerned, it is most imperative to research on the reinforcement of ideological and political education (Wang et al., 2016). Therefore, theoretical scores and technical scores are not all the evaluation criteria for education of comprehensive quality. Instead, it is how to redefine the direction for comprehensive quality education in accordance with social career development and make full use of education time that is the core subject.

1.2 Research purpose

According to the goal of college comprehensive quality education, this research redefined the evaluation criteria for comprehensive quality within time dimension and put forward the way of dividing initial levels of comprehensive quality to avoid lack of comprehensive quality education and imbalance in cultivation objects (Zeng et al., 2014). Besides, this research gathered statistics about students’ comprehensive quality education at different stages with the help of mathematical analysis matrix within time dimension and analysed current educational system reform through homogeneous Markov Linear Mathematical Modelling, hoping to offer theoretical references to educational reform and improve the direction and means of comprehensive quality education.

2. COLLEGE STUDENTS’ COMPREHENSIVE QUALITY ANALYSIS MODEL

The goal of college comprehensive quality education should be fulfilled within college time. Generally speaking, the length of schooling in China is 4 years for most majors, except for 5 years in particular for medicine majors and students usually spend three years in college and one in internship according to curriculum requirements, which makes education time indispensable when analysing the dimensions of comprehensive quality education which usually includes two indexes, namely, practical talents and compound talents, the qualities embodied by them being the objective forms of comprehensive quality education. Figure 1 shows the comprehensive quality ability constitution of college students.
2.1 The evaluation criteria for comprehensive quality education within time dimension

Generally speaking, the cultivation of comprehensive quality can’t reach its expectations if expected effects are not achieved within given education time. Therefore, the goal of college education is to complete their comprehensive quality cultivation within three years, which is hard to achieve due to two important factors (Zhao et al., 2016). One is individual qualification gap generated by different starting points yet having nothing to do with low education quality or lack of education methods, and the other is the bottleneck in students’ improvement at different stages, which makes it difficult for students to acquire various qualities at the same time, thus resulting in an extreme case of lack of certain qualities (Wang and Zheng, 2014). Both of the above factors make it difficult to achieve the education goal within given time and an inaccurate computing of education time will cause spillover effect that results in deviation from expected time.

2.2 Division of initial levels of comprehensive quality

Therefore, targeted education requires establishing education levels based on students’ individual differences, or dividing them into five levels, namely, excellent, good, medium, pass and fail according to their comprehensive quality ability, which can help education time fully play its part and also improve targeted teaching (Li et al., 2015). This research defines the state vector of the total number of students as $S(t)$, as is shown in the following formula:

$$S(t) = [x_1(t), x_2(t), ..., x_n(t)]$$

(1)

2.3 Mathematical analysis matrix within time dimension

Whether expected education goal can be achieved within time $T$ can be seen from the education reflections collected from 0 to $n$ months. Therefore, the education records of students in initialization vector $S(0)$ are very important in that students’ initial comprehensive quality is usually important evaluation basis in their education at different stages in order to guarantee objectivity and authenticity of teaching achievements. Whether students’ initial comprehensive quality is improved in the following months is shown in vector $A = (a_1, a_2, ..., a_n)$, and the transfer vectors of what students have improved are merged and cumulated into transfer matrix:

$$W = \begin{bmatrix}
    a_{11} & a_{12} & ... & a_{1i} \\
    a_{21} & a_{22} & ... & a_{2i} \\
    ... & ... & ... & ... \\
    a_{ni1} & a_{n12} & ... & a_{ni}
\end{bmatrix}$$

(2)

In the equation matrix, the comprehensive quality of students is achieved within expected time, and students of different levels all complete their comprehensive quality cultivation (Bo and Wu, 2015). However, the definition of time is not clear, so this research establishes a matrix arrangement and represents the above matrix as $T = A \times T + T = A \times T + 1$, in which $A$ means the differences among different levels of comprehensive quality and in transfer matrix forms unit matrix $T=[I-A]^{-1}$ with $I$ to represent the time that students of different levels need during comprehensive quality cultivation.
2.4 Test of comprehensive quality education uniformity ratio

As is the case, differences among individual students should be paid high emphasis during comprehensive quality education, so attention should also be paid to the students of different levels in the same sample to see whether they have received effective cultivation (Liu et al., 2014), of which the most important is to reduce education error within expected time. Therefore, one of the important evaluation criteria for teaching effect is whether comprehensive quality education has reached uniformity. Given that, this research sets the statistical quantization criteria as:

\[
2I = 2 \times \sum \ln [x(0)/x(e)]
\]  
(3)

This formula only compares the comprehensive quality education achievements of two pairs of students, with \(x(0)\) as observed value and \(x(e)\) as theoretical value, so as to see whether students’ comprehensive quality education have made ultimate achievements within expected time.

3. HOMOGENEOUS MARKOV LINEAR MATHEMATICAL MODELLING ANALYSIS

3.1 Homogeneous Markov Linear theory

Mathematical modelling is to explain the mechanism in which random variables change. Since the stochastic process is with Markov quality, variables in the mathematical model will be represented by their present states and won’t interact with previous variables (Lu et al., 2014). As discrete state usually results in ineffectiveness, a Markov process in one Markov chain can be seen as a discrete stochastic process and random time of \(Xr\) is represented as \(tr(r=1, 2)\).

3.2 Definition of theoretical value in mathematical model

The non-aftereffect property and homogeneity of time of homogeneous Markov chain are practical problems for evaluation on the same time index, and based on them, this research establishes a mathematical model to make evaluation about the effects that present teaching system has on students’ comprehensive quality cultivation and then based on the quantitative index of teaching effects and with comprehensive quality as the uniform reference variable, divides students into experimental group and contrast group of m levels. When \(m=5\), the comprehensive quality of students will be divided into excellent, good, medium, pass and fail, which makes it possible to see whether educational reform has made achievements in comprehensive quality cultivation. The discrete state of students in different level is also an objective criterion for the improvements made by them. On the basis of that the comprehensive quality of students are divided into different levels and their ratios can be represented as follows:

\[
R(t) = [x_1(t), x_2(t), ..., x_m(t)]
\]  
(4)

Here \(t\) represents the given education time and in the case of \(t \in N\), its theoretical value is:

\[
1 = \sum_{i=1}^{m} x_i(t)
\]  
(5)

3.3 The evaluation conditions for initial state vector

Take \(R(t)\) as the theoretical value of homogeneous Markov chain with the altered state of \(t\) as its state vector and summarize its change rules to get the homogeneous expression of time from Markov chain, which is free from the bounds of students’ starting points and improves the objective criteria of teaching quality evaluation. First, define the initial vector as:

\[
R(0)=[n_1/n, n_2/n, n_3/n, ..., n_m/n]
\]  
(6)

Here \(n\) represents the number of students, in which the initial vector represents the case that students already have initial comprehensive quality. The initial states of all the students in initial vector \(R(0)\) are considered the same so as to avoid the negative influence of individual differences, making it possible to objectively demonstrate the
same improvements made by students through computing and describe the matrix model of transition probability as:

\[ P_{ij} = [n_{ij}/n]_{m \times m} \] (7)

Here n represents the improvements of comprehensive quality from level i to level j with the increase of the number of students. The initial conditions of \( P_{ij} \) also reflect the present conditions and space for improvements of students so as to estimate the possibility when comprehensive quality of students increases to level j. If \( P_{ij} \geq 0 \), the possibilities of \( \sum_{i=1}^{m} P_{ij} = 1 \) can be drawn from conditions of i=1, 2…m. Therefore, this research establishes the mathematical model of the evaluation value of \( R(2) \) comprehensive quality.

\[ R(2) = R(0)P = \sum_{i=1}^{m} n_{im} / n \] (8)

4. THE RESEARCH ON EDUCATIONAL REFORM BASED ON COMPREHENSIVE QUALITY EVALUATION MODEL

The above theoretical model aims at comprehensive quality cultivation of students, so whether the targeted education can be completed within limited time is the core problem of educational reform. As only when \( R(2) \geq 1 \) can the feasibility of educational reform measures be evaluated, the cultivation of students at different stages when \( R(2) \geq 1 \) is also what should be affirmed during educational reform.

4.1 Gradient indexes for students’ comprehensive quality evaluation

Traditionally, teachers tended to evaluate the comprehensive quality of students based on their technical skills and theoretical knowledge which are also comprehensive indexes for present comprehensive quality education, though, yet offers no uniformed solutions for ideological and political education. And the fact is that without indexes of ideological and political education, the teaching system will be incomplete, while the integration of ideological and political education into comprehensive quality education evaluation will not directly quantify the bottom or ceiling lines of students’ codes of ethics (Shao and Han, 2014). Therefore, evaluation indexes cannot affirm uniformed criteria, nor can they verify whether students have made progress or not. Given that and based on advice from experts and relevant literature, this research divides college ideological and political education into three indexes, namely, cultural confidence, professionalism and code of conduct, which are also important research topics at present. Figure 2 shows the inner links among between the three indexes.

![Figure 2](image_url)

Figure 2. (Cultural Confidence/Professionalism/Code of Conduct) Support Dimension of Education for Comprehensive Quality

First, cultural confidence is the foundation for the rise of a nation as well as the ideological part of comprehensive quality education (Chen et al., 2014). As is indicated by many researches, cultural confidence make students more initiative and highly driven in both study and work, which offers good references for college education to set the
direction for cultural confidence cultivation in accordance with modern education. In that way, the motive of students can be fully stimulated to help them set goals for their study or even life as soon as possible and meet the ideological part of comprehensive quality education, thus contributing to the realization of education goals.

Second, professionalism essentially differs from professional skills in that the latter are important evaluation criteria on students’ technical skills, while the former, though within the scope of technical skills, yet has no relevance to skills (Chen et al., 2011). Professionalism can be evaluated according to the performances of students in internship. Nowadays, most enterprises consider professionalism as basic ethic requirements for employee, which is also the evaluation criterion for modern enterprises, so whether college students have these qualities should be the concern of the education system (Chen et al., 2011). As for students in internship, they should equip themselves with both strong technical skills and professional ethics so as to realize their values.

At last, code of conduct is established upon cultural confidence and professionalism. According to some researches on comprehensive quality education, some students, though well-equipped with professional knowledge and knowledge about code of ethics and standards of conduct, yet are unable to act in accordance with the ideological dimension, indicating that comprehensive quality education fails to meet expectations and practice and knowledge fail to be one (Wang et al., 2010). Therefore, this research takes code of conduct as the evaluation criterion of ideological and political education in comprehensive quality education as well as the comprehensive evaluation criteria for cultural confidence and professionalism.

4.2 Strategies for humanistic quality education with practice and knowledge being one

Since comprehensive quality education calls for practice and knowledge to be one, college education should put more emphasis on ideological and political education, in that comprehensive quality education based on technical skills and theoretical knowledge alone don’t meet the demands of new times and also go against the law of social development (Fu and Shi, 2010). Therefore, more emphasis should be put on humanistic quality education within comprehensive quality education, a way of equipping practical talents and compound talents with moral criteria. Only when students are cultivated with ethics through humanistic education can comprehensive quality education be complete in educational system and frames, for which the criteria is for practice and knowledge to be one. Considering all of that, this research sets three reference variables for practice and knowledge to be one, namely, X (seriously mistaken in ideology and scanty in code of conduct); Y (good in ideology and deficient in code of conduct); Z (highly harmonious in ideology and unified in code of conduct), the ultimate goal of comprehensive quality education. Put the scores of students at stages X and Y into formula \( I = \sum_{i=1}^{n} x_i(t) \), we will get unified criteria for evaluating students’ improvement space with education time. However, it needs to be verified by formula \( R(2) = R(0)P = \sum_{i=1}^{n} n_{im} / n \) about whether specific education goals have been realized. Besides, various methods are needed for evaluation on the education received by students at stages X and Y, including evaluations from students’ self-evaluation and that from teachers and among students, so as to affirm quantified criteria and make evaluation values more reliable and objective, upon which expected humanistic quality education goals will be achieved and the feasibility of the reform of comprehensive quality education will be proved.

5. CONCLUSION

The original intention of establishing the mathematical model of comprehensive quality education is to complete the cultivation of students’ comprehensive quality within limited teaching time based on an evaluation on students’ comprehensive quality ability. Although great demands exist for compound talents and practical talents, the leading role of ideological and political education should not be abandoned. Instead, the criteria of practice and knowledge to be one should be applied to evaluating teaching reform so as to improve students’ comprehensive quality ability in normal teaching process, all of which contributing to the cultivation of all round talents with strong comprehensive quality ability.

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