An evaluation index system of undergraduate education quality based on an analytic hierarchy process model

Xiaojing Liu

Wenzhou University
Wenzhou, Zhejiang, People's Republic of China

ABSTRACT: In today's competitive educational environment, the quality of undergraduate education is ever more recognised as a fundamental factor in gaining competitive advantage. The evaluation and improvement of the quality of undergraduate education in higher education is an important issue of on-going concern. The aim of this article is to focus on an automated management and evaluation system to efficiently control the administration of undergraduate education. Reported in this article is an evaluation index of the quality of undergraduate education, and an analytic hierarchy process (AHP) model that is both practical and has proven to be successful. The results of the presented case study demonstrate the practicability and effectiveness of this model in undergraduate education quality evaluation.

INTRODUCTION

In today's highly competitive marketplace, college students demand that education be of high quality, of reasonable cost, and with good support services. The evaluation of undergraduate education quality has become a feature of the higher education landscape [1]. On the one hand, undergraduate education quality assessments are being carried out by the new national funding bodies in response to the needs of society in the present age [2]. On the other hand, the major stakeholders in higher education increasingly want to be assured of the quality of undergraduate education.

In fact, the evaluation of education quality can be planned and implemented by small, independent task groups [3]. Heads of schools and evaluation departments have been encouraged to monitor the operation of their evaluation assessment schemes in order to improve educational quality [4]. Much experience in the higher education system has led to the conclusion that high quality is one of the keys to improving undergraduate education [5].

The content of this article touches upon the construction of an evaluation index system for undergraduate education quality. No attempt has been made to establish an absolute evaluation index system, because it is felt this would be not only impractical but also restrictive [6]. The present quality assessment systems for undergraduate education can be conveniently used in developing a new system [7]. The first step was to set up an evaluation index system involving the formal appraisal of staff performance and the effectiveness of the education process [8]. The second step was to set up a more effective evaluation model based on the analytic hierarchy process (AHP) method. The evaluation index system for undergraduate education quality is extremely varied [9].

After the literature review, the author introduces a new model for administrative management to strengthen the existing evaluation index system. In this article, the author attempts to provide a finished model for undergraduate education evaluation by using the AHP method. There are different qualitative and quantitative indicators for undergraduate education quality [10]. The aim of this study is to provide a tool to facilitate this. The effective assessment of the quality of undergraduate education is one of the keys for education administrators in implementing university education [11].

Research discussed in this article is logically ordered into various sections. First, the evaluation index system for undergraduate education quality based on the AHP method is presented. In the next section, the application of this evaluation index system is explained through a case study. Finally, conclusions are drawn.

EVALUATION INDEX SYSTEM FOR UNDERGRADUATE EDUCATION QUALITY

In such a diverse environment, there are a number of methods that can be applied. In the study outlined in this article, an evaluation index system of undergraduate education quality, based on an analytic hierarchy process model, was

applied [12]. A novel model is presented in this article for a college evaluation index system for undergraduate education quality. The proposed model and its evaluation index system would enable an undergraduate education quality evaluation.

THE AHP METHOD

The analytic hierarchy process or AHP method, which was established in 1977, is a popular way to solve multiple criteria decision problems [13]. The AHP method provides a comprehensive structure by which to combine both quantitative and qualitative criteria in the decision-making process. Practice has proven that the method is easy, comprehensive and logical [14]. Based on AHP, the factors involved in undergraduate education can be varied and a unified evaluation index system can be created.

In the AHP method, the problem is structured hierarchically in different levels. Any complex problem can be decomposed into several sub-problems using AHP, and hierarchical levels, where each level represents a set of criteria relative to each sub-problem [15]. As AHP is a very powerful method by which to solve complex decision problems, it was selected as the major tool in this study. Next, the simulation methods are described in detail.

The AHP method is based on the use of pair-wise comparisons, which lead to the elaboration of a ratio scale. In the AHP method, multiplicative preference relations are called judgment matrices, and are adopted to express the decision makers' preferences [16]. The pair-wise comparisons constitute square matrices, as shown in the matrix (1), the values of which are between 1/9 and 9.

$$\begin{bmatrix} 1 & x_{12} & \cdots & x_{1i} & \cdots & x_{1j} & \cdots & x_{1n} \\ 1/x_{12} & 1 & \cdots & x_{2i} & \cdots & x_{2j} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 1/x_{1i} & 1/x_{2i} & \cdots & 1 & \cdots & x_{ij} & \cdots & x_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 1/x_{1j} & 1/x_{2j} & \cdots & 1/x_{ij} & \cdots & 1 & \cdots & x_{jn} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 1/x_{1n} & 1/x_{2n} & \cdots & 1/x_{in} & \cdots & 1/x_{jn} & \cdots & 1 \end{bmatrix} \quad (1)$$

In AHP, the multi-criteria decision-making problem is first structured hierarchically. The two main steps of AHP are to rank consistency and the time it takes to make judgments in a complex decision problem, especially in cases where the number of decision alternatives is large. The consistency of weight coefficients is tested by related formulae. The most commonly used measure is the consistency index (CI), which can be calculated by:

$$CI = \frac{\lambda_{\max} - n}{n-1} \quad (2)$$

Where $\lambda_{\max}$ is the maximum eigenvalue of matrix *B*, and matrix *B* represents the consistency of condition attributes and decision attributes, as follows:

$$b_{ij} b_{jk} = b_{ik} \qquad \forall i, j, k \quad (3)$$

In order to find the most suitable way to estimate *how far* matrix *B* extends, the consistency indices are given.

As mentioned before, in this study, the AHP method was applied to evaluate the quality of undergraduate education. The AHP method searches and evaluates the cause and effect relationship between a goal and alternatives by breaking down the structure of the problem. Finally, the AHP method was used to measure education quality by utilising the evaluation index system.

PROPOSED EVALUATION INDEX SYSTEM BASED ON THE AHP METHOD

As the pace of market globalisation quickens, the number of potential evaluation indices of undergraduate education quality assessment increases; and the aim of this study was to develop an evaluation index system of undergraduate education quality that would be effective and efficient. A large attribute set has been reduced and transformed into a lesser number of sub-targets to facilitate the evaluation of education quality.

This study introduced the AHP method to establish an integrated evaluation model. The undergraduate quality education problem involves analysing and measuring the performance of a set of candidate indicators. The proposed evaluation index system for undergraduate education quality is shown in Figure 1.

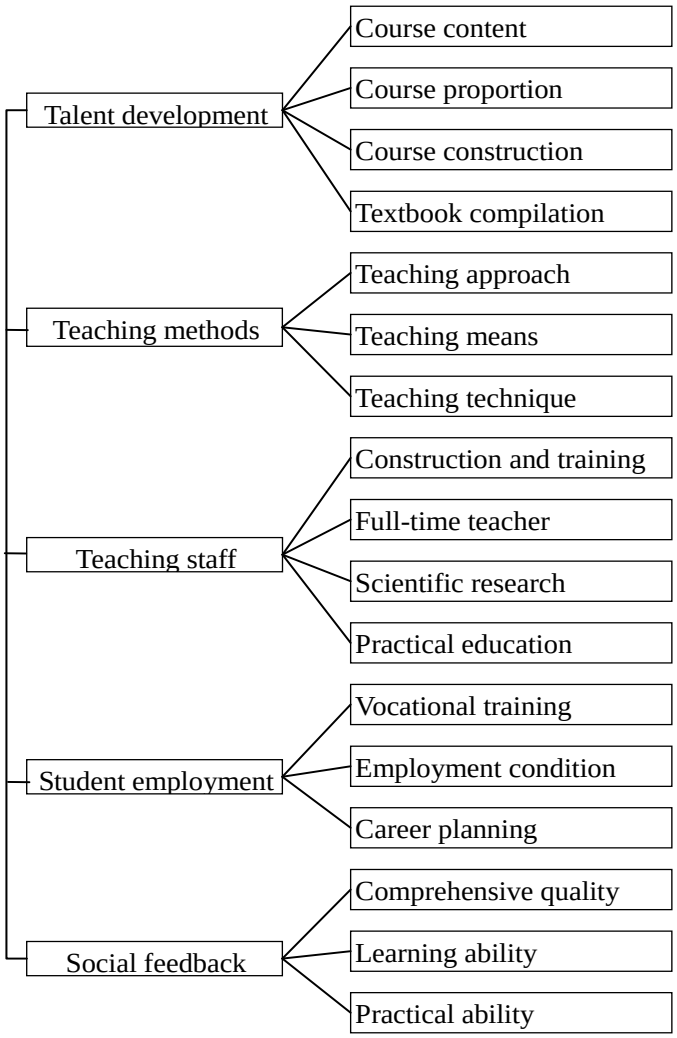

Figure 1: Evaluation index system for undergraduate education quality.

The sub-criteria for the main indicators are as follows:

A. Talent development. It is the key for undergraduate education.

- *Course content*: The course content will help students meet the objectives and goals of their study.
- *Course proportion:* It requires a certain amount of time, affecting the depth of study.
- *Course construction*: The level of course construction is the main mark of the university
- *Textbook compilation*: It must meet the students' study needs.

B. Teaching methods. It is the key for undergraduate education.

- *Teaching approach*: A qualified college teacher should consult advanced new theories and combine these with real teaching experiences in class.
- *Teaching means*: The use of *modern teaching means* affects and changes classroom teaching.
- *Teaching technique*: Teachers should make good use of modern teaching technique.

C. Teaching staff. Teaching staff should be highly professional, experienced and committed to providing high quality learning experiences.

- *Construction and training*: Teachers' training plays a great role in the development of teaching staff at universities.
- *Full-time teacher*: Full-time employment teachers should have a rich experience, as they provide a good education service for the college student.
- *Scientific research*: Scientific research will be an important subject for teaching staff in the future.
- *Practical education*: A more practical education would give the college better scientists and entrepreneurs.

D. *Student employment*. It plays a very important role in personnel training and student employment.

- *Vocational training:* In order to address the country's unemployment crisis, it is very important to provide students with vocational training.
- *Employment conditions*: The employability of undergraduates is an important index by which to measure the level of education quality.
- *Career planning*: Career planning is a multi-step process requiring self-reflection.

E. *Social feedback*. The social feedback of college graduates is greatly valued in undergraduate education construction.

- *Comprehensive quality*: Researchers point out that an undergraduate should improve his or her own qualities in many ways.
- *Learning ability*: The success of college students' study will be built upon their learning ability rather than what they already know.
- *Practical ability*: Practical ability is at the heart of quality in undergraduate education.

The evaluation index system of quality in education is the key to fulfilling the aim of developing talent in undergraduates at universities.

CASE STUDY OF UNDERGRADUATE EDUCATION QUALITY EVALUATION

During the case study, the AHP method was applied to solve the problem of undergraduate education quality evaluation. The proposed evaluation index was used by an independent college in China's Zhejiang province. The staff implemented an undergraduate evaluation in their departments as part of a quality assurance process. It included a total of 17 criteria, divided into five cognate groups covering all the basic aspects of the college course. The evaluation index system of undergraduate education quality is shown in Figure 1. The criteria were based on the overall aims and objectives of the undergraduate course.

In the study, the AHP method was applied to screen indexes and the weight coefficients were defined. According to the proposed model, the estimation of an evaluation index system of undergraduate education quality involves the following phases. First, an investigation was carried out of current undergraduate education quality. Second, an analysis was made of the legitimacy of the evaluation index system. Third, the evaluation process was transformed into concrete operational procedures and standards. At the same time, the evaluation indexes to evaluate undergraduate education quality were selected. However, when the data are collected, it will be necessary for respondents to determine the complicated network of the state-education relationships.

Thus, it was found that these proposals are not only very effective in helping AHP decision makers to reach consensus, but they also provide convincing alternatives for undergraduate education quality. Based on the findings from the preceding literature reviews, an AHP model was formulated to evaluate undergraduate education quality, as shown in Figure 1. To follow, the models of AHP were studied, and the AHP algorithm was analysed. Then, the AHP method was used to determine the weights of the evaluation index system for undergraduate education quality. The basic information with respect to index weights is shown in Table 1.

Table 1: Evaluation index system and index weights.

First class index		Second class index	
Index name	Index weights	Index name	Index weights
A: Talent development	0.285	A_1: Course content	0.137
		A_2: Course proportion	0.284
		A_3: Course construction	0.193
		A_4: Textbook compilation	0.386
B: Teaching methods	0.207	B_1: Teaching approach	0.364
		B_2: Teaching means	0.245
		B_3: Teaching technique	0.391
C: Teaching staff	0.116	C_1: Construction and training	0.216
		C_2: Full-time teacher	0.183
		C_3: Scientific research	0.327
		C_4: Practical education	0.274

D: Student employment	0.228	D_1: Vocational training	0.358
		D_2: Employment conditions	0.241
		D_3: Career planning	0.401
E: Social feedback	0.164	E_1: Comprehensive quality	0.315
		E_2: Learning ability	0.428
		E_3: Practical ability	0.257

At each time step, the index weight was calculated for each indicator according to the AHP method. A simple example was used and the detailed computation was as follows:

$A = 0.285 \times (0.137A_1 + 0.284\ A_2 + 0.193\ A_3 + 0.386\ A_4)$
$B = 0.207 \times (0.364\ B_1 + 0.245\ B_2 + 0.391\ B_3)$
$C = 0.116 \times (0.216\ C_1 + 0.183\ C_2 + 0.327\ C_3 + 0.274\ C_4)$
$D = 0.228 \times (0.358\ D_1 + 0.241\ D_2 + 0.401\ D_3)$
$E = 0.164 \times (0.315\ E_1 + 0.428\ E_2 + 0.257\ E_3)$

$F = A + B + C + D + E$

Similarly, the other index weights can be obtained based on AHP. Finally, through comparing weights, the proximity between the evaluation index system and the ideal system was judged. With the development of higher education reform in China, the evaluation index system for undergraduate education quality is a new process for Chinese universities.

The problem needs to be addressed as to how to reform and improve the original undergraduate evaluation model to further enhance the quality of higher education. With the expansion of higher education, undergraduate teaching quality is at the core of higher education. In this article, a method was proposed by which to rank undergraduate institutions based on education quality and the achievements of their graduates.

CONCLUSIONS

The overall purpose of this article was to explore and contribute to an evaluative process for undergraduate education quality. Automated evaluation makes the difficult task of evaluating undergraduate education quality, simple and easy. The feedback received from the various institutions indicated that the evaluation index system has proved successful in achieving its various aims.

The evaluation results also provided a great deal of useful information about the effectiveness of the approved AHP model used in the education quality assessment process. At the same time, this work should prove its value as an empirical reference for other evaluation index systems for undergraduate education quality for other nations or states. It is also hoped that it will be of interest to colleagues, and the author would be pleased to provide further information about the evaluation of undergraduate education quality.

REFERENCES

1. Al-Mushasha, N.F. and Nassuora, A.B., Factors determining e-learning service quality in jordanian higher education environment. *J. of Applied Sciences*, 12, **14**, 1474-1480 (2012).
2. Engel, G., Impagliazzo, J. and Lamalva, P., A brief history of the Computing Sciences Accreditation Board (CSAB) promoting quality education in the computing fields. *ACM Inroads*, 1, **2**, 62-69 (2010).
3. Doloswala, K.N., Thompson, D. and Toner, P., Digital based media design: the innovative contribution of design graduates from vocational and higher education sectors. *Inter. J. of Technol. and Design Educ.*, 23, **2,** 409-423 (2013).
4. Pears, A.N., Does quality assurance enhance the quality of computing education? *Proc. Conf. on Research and Practice in Infor. Technol. Series*, Brisbane, Australia, 9-14 (2010).
5. Pires, A., Chang, N-B. and Martinho, G., An AHP-based fuzzy interval TOPSIS assessment for sustainable expansion of the solid waste management system in Setubal Peninsula, Portugal. *Resources, Conservation and Recycling*, 56, **1**, 7-21 (2011).
6. Kirkwood, A. and Price, L., Examining some assumptions and limitations of research on the effects of emerging technologies for teaching and learning in higher education. *British J. of Educational Technol.*, 44, **4**, 536-543 (2013).
7. Aparicio, F., De-Buenaga, M., Rubio, M. and Hernando, A., An intelligent information access system assisting a case based learning methodology evaluated in higher education with medical students. *Computers and Educ.*, 58, **4,** 1282-1295 (2012).
8. Hrastinski, S. and Dennen, V., Social media in higher education: introduction to the special issue. *Internet and Higher Educ.*, 15, **1**, 1-2 (2012).

9. Tess, P.A., The role of social media in higher education classes (real and virtual) - a literature review. *Computers in Human Behavior*, 29, **5**, 60-68(2013).
10. Peercy, P.S. and Cramer, S.M., Redefining quality in engineering education through hybrid instruction. *J. of Engng. Educ.*, 100, **4**, 625-629 (2011).
11. Siddiqui, A.T. and Masud, M., An e-learning system for quality education. *Inter. J. of Computer Science Issues*, 9, **4**, 375-380 (2012).
12. Kukulska-Hulme, A., How should the higher education workforce adapt to advancements in technology for teaching and learning? *Internet and Higher Educ.*, 15, **4**, 247-254 (2012).
13. Brunelli, M., Critch, A. and Fedrizzi, M., A note on the proportionality between some consistency indices in the AHP. *Applied Mathematics and Computation*, 219, **14**, 7901-7906 (2013).
14. Dalal, J., Mohapatra, P.K.J. and Mitra, G.C., Prioritization of rural roads: AHP in group decision. *Engng., Construction and Architectural Manage.*, 17, **2**, 135-158 (2010).
15. Ishizaka, A., Pearman, C. and Nemery, P., AHPSort: an AHP-based method for sorting problems. *Inter. J. of Production Research*, 50, **17**, 4767-4784 (2012).
16. Raisbeck, P. and Tang, L.C.M., Identifying design development factors in Australian PPP projects using an AHP framework. *Construction Manage. and Economics*, 31, **1**, 20-39 (2013).