

The Research of the Application of the Fuzzy Synthetic Decision on Electronic Practice Course in the Junior College in Taiwan, R.O.C.

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Abstract — *The practice course is one of the important instruction processes. Since the aim of this course is to let the students learn from what they actual do in the laboratory. So many learning theories can be verified. Moreover, the student's effect of learning can be fostered. In the course of the practical operation, many influential teaching factors are thus found. In this way, these factors are first itemized, grouped, weighted, then analyzed, and improved, because the data collected can be used as the basis of the teaching reforms.*

In this research, the Fuzzy analysis is employed. The researcher, at first, focuses on the factors mentioned. He not only deletes the existing fuzzy phenomena, he also scraps away the bias of quantified analysis in general linear statistics. After that, he co-ordinates the education theories with the teaching based on the Fuzzy theory by means of the small amount of sample size. Furthermore, he makes use of the Fuzzy math to quantify the data. Next, these data must be under the quality analysis. Finally, he makes many specific suggestions based on the mentioned data.

INTRODUCTION

Economy and education are two important indicators for evaluating the degree of a country's modernization. They are just like two sides of a coin. So, they are closely related with each other. Education fosters the growth of economy, and the growth of economy changes people concepts toward education, thus inevitable effects can be found in the progress of education. These provide the economic sector with human power needed. At the same time, the growth of economy renders employment opportunities for the people. The forty years' economic growth in the Taiwan area, from the process of having 'nothing' to 'something', creates the economic miracle, which is famous in the world. How did this happen? In addition to the appropriateness of the government policies and the diligence of the people, the most important factor comes from the technical human power sector. [1]

In order to cultivate excellent technical human power actively, the technical education always complies with the impulse of the era and the needs of the society. Its aim focuses not only on the students' immediate employment after graduation, but also the exploration of the student learning potentialities, which can be utilized in their jobs. [1] Therefore, what ways can be used to make students adapt to the present era of speedily technical changes and explosive

increase of the different kinds of knowledge. How can they acquire the most effective learning? Professor Chen induces the ways of learning into three simple types:

1. By attempts and wrongdoings
2. By observing.
3. By doing. [2]

Professor Chen points out the way of learning by attempts and wrongdoings is not the best, but it is the easiest. Concepts required must be learned by observation. However, the acquisition of skills must be achieved by doing. These statements indicate that, in technical education, both theory learning and practice learning are of the same importance. Therefore, there are practice and training courses in vocational high schools, junior colleges, and even colleges of technology. Thus, different kinds of theories can be verified and many skills can be manipulated. [3]

In human thinking and languages, many concepts are obscure. The whole thinking process is quite complicated and unclear. However, human not only can discriminate and handle these inexplicable and indefinite amount of messages, they also can draw meaningful information from them. [4] From time to time, the general way of study is carried out by means of taking questionnaires. The occurrence of the testee obscurity will affect the evaluation. In this way, the system quantified analysis in the general linear statistics can produce differences.

The simplest way of integrated evaluation is the total score evaluation, that means the quantification of the goals of the system. Then, the quantified total score can be used to determine the merits and defects of the system. Since every factor has different degree of influence to the system. So the importance of each factor must be distinguished and expressed by weighted mean. [5] Moreover, the data drawn are induced and calculated by means of the Fuzzy math. And the final result must be analyzed and evaluated. [6] Because of its value on efficacy and reference, this method can be applied to the system analysis employed in the practice course of the junior college. Furthermore, it can eliminate the defects found in the present practice course.

FUZZY THEORY

The Fuzzy theory serves as a bridge between the explicit math world and the present obscure world. It can make human's specialized knowledge, experience and techniques infuse with the analysis of the computer and practical control

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of the machinery. Its control method is very flexible, and the object of analysis is also very active. If it is applied correctly, the system of experts and specialists can be set up in every sphere. [7]

The basic aims of the Fuzzy theory is to formulate the unclear process of human knowledge and the messages of technical skills efficiently. The applications are [8] :

1. To investigate into the characteristics of personal, social and association etc., so as to plot perfect designs for them.
2. To make the human special detecting and message-handling abilities virtual. These are based on the knowledge and experience of experts concerned, so as to design, evaluate and discriminate, decide and control the abilities.

Many concepts in human thinking, languages and general behaviors are unclear. Professor L. A. Zadeh of California University firstly declared the Fuzzy theory in 1965. [9] He believes that the traditional explicit quantified method is not completely suitable in human-centered system. It also can not be applied to the cognitive problems in the system. So, the proposal of the concept of Fuzzy sets is to emphasis the fuzziness in the process of human thinking and reasoning. The Fuzzy calculus analysis is considered to replace the traditional quantified method. [10] Since its special usage, and its scientific solving function for uncertain problems, this method is accepted in fields of automatic-control, administration, economy, finance, and education. [11] [12]

The Fuzzy theory focuses on handling the human obscurity. Administrators, educators and technical workers can make use of it to carry out elaborate control work or evaluation. Its aim is based on making the unclear human thinking and discrimination virtual. Decision and discrimination are made after the fusion of the different conditions and the human already-acquired knowledge, skills and experience, with appropriate adjustments. The Fuzzy examination is a kind of explicit extension. The main object is to investigate into the obscure human attitude during the processes of discriminating or deciding and evaluating. [9]

FUZZY SYNTHETIC DECISION

Decision Questionnaire

In order to consider Fuzzy math handling factors affecting the teaching efficacy in practice course, the researchers must carry out questionnaire research. Since the object is the student, so the items must not be beyond their comprehension.

In practice course, the main decision items include: syllabus, teaching materials, apparatus and materials, teaching facilities, teaching techniques, teaching environment, teacher experience and academic

achievements, and administration assistance. Each main item is divided into several sub decision items.

1. Syllabus: aims, structures, course links, required practice course, teaching hours.
2. Teaching Materials: text books, general contents, difficulties, content, renewal and supplement.
3. Apparatus And Materials: apparatus provided, apparatus rendered, tools and materials in practice course.
4. Teaching Facilities: the design of the laboratory factory, the size of the laboratory factory, the number of the laboratory factory, the safety and hygiene of the laboratory factory, and the guidance of it.
5. Teaching Methods: schedule, method, apparatus, media, mutual relation between the students and the teachers, problem-solving and supplementary classes.
6. Teaching Environment: the classroom atmosphere, the understanding of the student learning efficacy, the contact with the parents, and the links with the other teachers related.
7. Teacher Experience And Academic Achievements: registers, licenses, works related, practical experiences, years of teaching.
8. Administration Assistance: reference books, expenditure, arrangement of the teaching hours according to the teacher specific knowledge.

According to the concept of obscurity, the evaluation standard of each decision item, is divided into 'n' grade. In this passage, the influential degree of the factors affecting practice course is classified into five grades. The decision set is $V=v_1, v_2, v_3, v_4, v_5$ which means 'very important', 'important', 'general', 'not important', and 'not very important', respectively. The main decision items are represented by factor sets $U=(u_1, u_2, u_3, u_4, u_5..u_8)$, (Table 1)

1. u_1 : Syllabus,
2. u_2 : Teaching Materials
3. u_3 : Apparatus And Materials
4. u_4 : Teaching Facilities
5. u_5 : Teaching Methods
6. u_6 : Teaching Environment
7. u_7 : Teacher Experience And Academic Achievements
8. u_8 : Administration Assistance

Decision Membership Functions and Weighting Numbers

Decision membership function is the basic concept in Fuzzy math, the Fuzzy sets in a given zone are expressed in concrete number value to represent the grade of membership. In Fuzzy math, after the process of sorting the data drawn,

itemizing them and quantifying them into the degree of membership are two necessary steps.

In the Fuzzy sets theory, the relation between a Fuzzy set and a substance is no longer stated as ‘being subordinate’ or ‘not being subordinate’ to the substance. The Fuzzy sets theory is represented by the indicator of the grade of membership. The grade of membership is to represent the degree of being subordinate from a substance to the specific Fuzzy sets. And, the math definitions related are:

1. **C**: Substance under the same classification
2. **X**: Universe of discourse
3. **A**: Fuzzy sets
4. **fA**: A is a membership function

If **X** is a function set $fA(\mathbf{C}) : X \rightarrow [0, 1]$

Thus, $A = \{ \mathbf{C}, fA(\mathbf{C}) \mid \mathbf{C} \in X \}$

fA is the sub Fuzzy set of **X**

fA is a membership function of **A**

Hence,

1. $fA : \mathbf{C} \rightarrow fA(\mathbf{C}) \quad \mathbf{C} \in X \quad 0 \leq fA(\mathbf{C}) \leq 1$
2. When $fA(\mathbf{C})=0$, represents $\mathbf{C} \notin A$ (\mathbf{C} does not belong to **A**)
3. When $fA(\mathbf{C})=1$, represents $\mathbf{C} \in A$ (\mathbf{C} belongs to **A**)
4. When $0 < fA(\mathbf{C}) < 1$, represents \mathbf{C} to a certain degree belongs to **A**, the bigger in number the $fA(\mathbf{C})$ is, the greater the degree of membership to **A** is.

Synthetic Decision

Although we have obscurity in the environment and the parties employed in the process of teaching, we still have ways of regularity to follow. In this way, the value evaluation of obscurity on teaching efficacy is catching more and more attention. The synthetic decision is the fusion of quantified education theory and Fuzzy math. The data drawn, then, are observed under the quantified analysis in the education study.

The Synthetic decision is the overall evaluation on a specific phenomenon. This decision is an indispensable procedure in education. Whatever methods are taken in education evaluation, the data drawn must be observed under decision. [9]

If $R_i (i = 1, 2, \dots, m)$ represents ‘m’ sets of factors affecting the aims of the system, thus, relative array is represented by

$$R = \begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_m \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

So, the formula for the combination of the Fuzzy Synthetic decision is:

$$B = A \circ R$$

$$B = (a_1 a_2 \cdots a_m) \circ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} = (b_1 b_2 \cdots b_n)$$

A is the mapping for the set of the weighting numbers, and the calculation symbol

$$b_j = \bigvee_{i=1}^m (a_i \wedge r_{ij}) \quad (j=1,2,\dots,n), \quad b_j (j=1,2,\dots,n)$$

is called the Fuzzy decision indicator. After being inducing, it will become

$$S_j = \frac{b_j}{\sum_{k=1}^n b_k} \quad (j=1,2,\dots,n)$$

$S_j (j=1,2,\dots,n)$ is called the Synthetic decision indicator.

[5]

Procedures For Synthetic Decision

The main steps for Synthetic decision are:

1. To set up sets of factor analysis and sets of weighting numbers.
2. To set up membership functions.
3. To set up sets of Fuzzy decision indicators.
4. To set up sets for indicators of Synthetic decision, after the data drawn is induced.

CASE STUDY

Methods

The practice course in teaching procedure always influences the efficacy of the whole teaching process. The learning efficacy is greatly benefited by means of the examination and actual operation of the theories. Therefore, it is necessary to set up sets of the factors affecting the whole education process. This includes syllabus, teaching materials, equipment and materials, teaching facilities, teaching methods, teaching environment, teacher experience and academic achievements, and administration assistance. Then, the above-mentioned topics have to be itemized and grouped. Moreover, the establishment of the sets of weighting numbers is the next step. And, the five-graded system is followed, and necessarily divided into the states of ‘Very important’, ‘important’, ‘general’, ‘Not very important’, and ‘Not important’.

The aim is to set up arrays for combination calculation and decision analysis.

The whole study is carried out by the method based on the Fuzzy analysis by means of the small amount of sample size. The objects of the study are the eighty-five students from the Department of Electronics in the Sze Hai Institute of Technology and commerce. They are required to take the

questionnaires in the form of the decision items, so as to find out their grades of membership toward learning. After that, the data is calculated and decided.

Procedures

At first, the researchers sorted and itemized all the possible factors influencing the efficacy of the practice course. Then, the information was systematically classified into 'n' graded decision items. Each classification was divided into several sub-divisions. They were represented as sets of factors, like $U = (u_1, u_2, u_3 \dots \dots u_8)$ (See Table 2)

Weighting numbers mean the degree of influence from the sub-divisions of one specific classification to the previous classification. It means the degree of importance of one specific classification to the whole case. Generally, this can be calculated by the selection of the opinions from the scholars and experts related or judgements based on experience, with appropriate waiting ratio numbers.

The table for the weighting ratio numbers is set up after ten experienced teachers related finished taking the questionnaire. (see Table 3):

- $R_1 = (0.235 \ 0.353 \ 0.353 \ 0.059 \ 0)$
- $R_2 = (0.188 \ 0.365 \ 0.282 \ 0.118 \ 0.047)$
- $R_3 = (0.306 \ 0.329 \ 0.235 \ 0.070 \ 0.059)$
- $R_4 = (0.447 \ 0.353 \ 0.188 \ 0.012 \ 0)$
- $R_5 = (0.176 \ 0.306 \ 0.376 \ 0.082 \ 0.059)$
- $R_6 = (0.353 \ 0.353 \ 0.188 \ 0.070 \ 0.035)$
- $R_7 = (0.153 \ 0.294 \ 0.435 \ 0.070 \ 0.047)$
- $R_8 = (0.494 \ 0.376 \ 0.094 \ 0.035 \ 0)$
- $R_9 = (0.176 \ 0.529 \ 0.294 \ 0 \ 0)$
- $R_{10} = (0.294 \ 0.424 \ 0.176 \ 0.059 \ 0.047)$
- $R_{11} = (0.294 \ 0.376 \ 0.188 \ 0.094 \ 0.047)$
- $R_{12} = (0.459 \ 0.329 \ 0.118 \ 0.082 \ 0.012)$
- $R_{13} = (0.353 \ 0.353 \ 0.176 \ 0.059 \ 0.059)$
- $R_{14} = (0.412 \ 0.306 \ 0.235 \ 0.047 \ 0)$
- $R_{15} = (0.341 \ 0.353 \ 0.176 \ 0.118 \ 0)$
- $R_{16} = (0.353 \ 0.294 \ 0.141 \ 0.141 \ 0.071)$
- $R_{17} = (0.294 \ 0.306 \ 0.212 \ 0.118 \ 0.071)$
- $R_{12} = (0.459 \ 0.329 \ 0.118 \ 0.082 \ 0.012)$
- $R_{13} = (0.353 \ 0.353 \ 0.176 \ 0.059 \ 0.059)$
- $R_{14} = (0.412 \ 0.306 \ 0.235 \ 0.047 \ 0)$
- $R_{15} = (0.341 \ 0.353 \ 0.176 \ 0.118 \ 0)$
- $R_{16} = (0.353 \ 0.294 \ 0.141 \ 0.141 \ 0.071)$
- $R_{17} = (0.294 \ 0.306 \ 0.212 \ 0.118 \ 0.071)$
- $R_{18} = (0.235 \ 0.306 \ 0.294 \ 0.094 \ 0.071)$
- $R_{19} = (0.471 \ 0.306 \ 0.176 \ 0.047 \ 0)$
- $R_{20} = (0.412 \ 0.329 \ 0.141 \ 0.094 \ 0.024)$

- $R_{21} = (0.424 \ 0.294 \ 0.235 \ 0.047 \ 0)$
- $R_{22} = (0.329 \ 0.306 \ 0.247 \ 0.082 \ 0.035)$
- $R_{23} = (0.224 \ 0.282 \ 0.365 \ 0.094 \ 0.035)$
- $R_{24} = (0.435 \ 0.294 \ 0.235 \ 0.035 \ 0)$
- $R_{25} = (0.353 \ 0.282 \ 0.224 \ 0.118 \ 0.024)$
- $R_{26} = (0.282 \ 0.306 \ 0.235 \ 0.153 \ 0.024)$
- $R_{27} = (0.435 \ 0.282 \ 0.212 \ 0.047 \ 0.024)$
- $R_{28} = (0.412 \ 0.306 \ 0.235 \ 0.047 \ 0)$
- $R_{29} = (0.118 \ 0.165 \ 0.412 \ 0.247 \ 0.059)$
- $R_{30} = (0.235 \ 0.247 \ 0.188 \ 0.212 \ 0.118)$
- $R_{31} = (0.235 \ 0.400 \ 0.165 \ 0.118 \ 0.082)$
- $R_{32} = (0.294 \ 0.247 \ 0.318 \ 0.118 \ 0.024)$
- $R_{33} = (0.412 \ 0.306 \ 0.235 \ 0.047 \ 0)$
- $R_{34} = (0.435 \ 0.294 \ 0.247 \ 0.024 \ 0)$
- $R_{35} = (0.400 \ 0.329 \ 0.176 \ 0.071 \ 0.024)$
- $R_{36} = (0.424 \ 0.282 \ 0.212 \ 0.047 \ 0.035)$
- $R_{37} = (0.471 \ 0.353 \ 0.118 \ 0.058 \ 0)$
- $R_{38} = (0.447 \ 0.247 \ 0.212 \ 0.094 \ 0)$
- $R_{39} = (0.294 \ 0.318 \ 0.188 \ 0.082 \ 0.118)$
- $R_{40} = (0.235 \ 0.365 \ 0.235 \ 0.094 \ 0.071)$

$$B_1 = A_1 \circ \begin{bmatrix} R_1 \\ R_2 \\ R_3 \\ R_4 \\ R_5 \end{bmatrix} = (0.16 \ 0.11 \ 0.25 \ 0.28 \ 0.20) \circ \begin{bmatrix} 0.235 & 0.353 & 0.353 & 0.059 & 0 \\ 0.188 & 0.365 & 0.288 & 0.118 & 0.047 \\ 0.306 & 0.329 & 0.235 & 0.070 & 0.059 \\ 0.447 & 0.353 & 0.188 & 0.012 & 0 \\ 0.176 & 0.306 & 0.376 & 0.082 & 0.059 \end{bmatrix}$$

$$B_1 = (0.295 \ 0.339 \ 0.275 \ 0.060 \ 0.031)$$

$$B_2 = A_2 \circ \begin{bmatrix} R_6 \\ R_7 \\ R_8 \\ R_9 \\ R_{10} \end{bmatrix} = (0.22 \ 0.12 \ 0.25 \ 0.26 \ 0.15) \circ \begin{bmatrix} 0.353 & 0.353 & 0.188 & 0.070 & 0.035 \\ 0.153 & 0.294 & 0.435 & 0.070 & 0.047 \\ 0.494 & 0.376 & 0.094 & 0.035 & 0 \\ 0.176 & 0.529 & 0.294 & 0 & 0 \\ 0.294 & 0.424 & 0.176 & 0.059 & 0.047 \end{bmatrix}$$

$$B_2 = (0.309 \ 0.408 \ 0.143 \ 0.041 \ 0.020)$$

$$B_3 = A_3 \circ \begin{bmatrix} R_{11} \\ R_{12} \\ R_{13} \\ R_{14} \end{bmatrix} = (0.16 \ 0.26 \ 0.28 \ 0.38) \circ \begin{bmatrix} 0.294 & 0.376 & 0.188 & 0.094 & 0.047 \\ 0.459 & 0.329 & 0.118 & 0.082 & 0.012 \\ 0.353 & 0.353 & 0.176 & 0.059 & 0.059 \\ 0.412 & 0.306 & 0.235 & 0.047 & 0 \end{bmatrix}$$

$$B_3 = (0.389 \ 0.336 \ 0.181 \ 0.014 \ 0.027)$$

$$B^4 = A^4 \circ \begin{bmatrix} R_{15} \\ R_{16} \\ R_{17} \\ R_{18} \\ R_{19} \\ R_{20} \end{bmatrix} = (0.15 \ 0.24 \ 0.26 \ 0.07 \ 0.28) \circ \begin{bmatrix} 0.341 & 0.353 & 0.176 & 0.118 & 0 \\ 0.353 & 0.294 & 0.141 & 0.141 & 0.071 \\ 0.294 & 0.306 & 0.212 & 0.118 & 0.071 \\ 0.235 & 0.306 & 0.294 & 0.094 & 0.071 \\ \dots & \dots & \dots & \dots & \dots \end{bmatrix}$$

$$B_4 = (0.361 \ 0.310 \ 0.185 \ 0.102 \ 0.040)$$

$$B_3 = A_3 \circ \begin{matrix} R_{20} \\ R_{21} \\ R_{22} \\ R_{23} \\ R_{24} \\ R_{25} \\ R_{26} \end{matrix} = (0.18 \ 0.16 \ 0.20 \ 0.08 \ 0.15 \ 0.05) \circ \begin{matrix} 0.42 & 0.329 & 0.141 & 0.094 & 0.024 \\ 0.424 & 0.294 & 0.235 & 0.047 & 0 \\ 0.329 & 0.306 & 0.247 & 0.082 & 0.035 \\ 0.224 & 0.282 & 0.365 & 0.094 & 0.035 \\ 0.435 & 0.294 & 0.235 & 0.035 & 0 \\ 0.353 & 0.282 & 0.224 & 0.118 & 0.024 \\ 0.282 & 0.306 & 0.235 & 0.153 & 0.024 \end{matrix}$$

$$B_5 = (0.373 \ 0.301 \ 0.229 \ 0.080 \ 0.013)$$

$$B_6 = A_6 \circ \begin{matrix} R_{27} \\ R_{28} \\ R_{29} \\ R_{30} \end{matrix} = (0.25 \ 0.28 \ 0.23 \ 0.24) \circ \begin{matrix} 0.435 & 0.282 & 0.212 & 0.047 & 0.024 \\ 0.412 & 0.306 & 0.235 & 0.047 & 0 \\ 0.118 & 0.165 & 0.412 & 0.247 & 0.059 \\ 0.235 & 0.247 & 0.188 & 0.212 & 0.118 \end{matrix}$$

$$B_6 = (0.308 \ 0.253 \ 0.259 \ 0.133 \ 0.048)$$

$$B_7 = A_7 \circ \begin{matrix} R_{31} \\ R_{32} \\ R_{33} \\ R_{34} \\ R_{35} \end{matrix} = (0.14 \ 0.12 \ 0.18 \ 0.30 \ 0.26) \circ \begin{matrix} 0.235 & 0.400 & 0.165 & 0.118 & 0.082 \\ 0.294 & 0.247 & 0.318 & 0.118 & 0.024 \\ 0.412 & 0.306 & 0.235 & 0.047 & 0 \\ 0.435 & 0.294 & 0.247 & 0.024 & 0 \\ 0.400 & 0.329 & 0.176 & 0.071 & 0.024 \end{matrix}$$

$$B_7 = (0.377 \ 0.314 \ 0.223 \ 0.065 \ 0.021)$$

$$B_8 = A_8 \circ \begin{matrix} R_{36} \\ R_{37} \\ R_{38} \\ R_{39} \\ R_{40} \end{matrix} = (0.18 \ 0.28 \ 0.27 \ 0.07 \ 0.20) \circ \begin{matrix} 0.424 & 0.282 & 0.212 & 0.047 & 0.035 \\ 0.471 & 0.353 & 0.118 & 0.058 & 0 \\ 0.447 & 0.247 & 0.212 & 0.094 & 0 \\ 0.294 & 0.318 & 0.188 & 0.082 & 0.118 \\ 0.235 & 0.365 & 0.235 & 0.094 & 0.071 \end{matrix}$$

$$B_8 = (0.396 \ 0.312 \ 0.189 \ 0.189 \ 0.075 \ 0.029)$$

From the following, the membership functions of the sub decision items are:

$$S_1 = (0.295 \ 0.339 \ 0.275 \ 0.060 \ 0.031)$$

$$S_2 = (0.336 \ 0.443 \ 0.155 \ 0.045 \ 0.021)$$

$$S_3 = (0.411 \ 0.355 \ 0.191 \ 0.015 \ 0.029)$$

$$S_4 = (0.362 \ 0.311 \ 0.185 \ 0.102 \ 0.040)$$

$$S_5 = (0.374 \ 0.302 \ 0.230 \ 0.080 \ 0.013)$$

$$S_6 = (0.308 \ 0.253 \ 0.259 \ 0.133 \ 0.048)$$

$$S_7 = (0.377 \ 0.314 \ 0.223 \ 0.065 \ 0.021)$$

$$S_8 = (0.395 \ 0.312 \ 0.189 \ 0.075 \ 0.029)$$

$$B = A \circ \begin{matrix} S_1 \\ S_2 \\ S_3 \\ S_4 \\ \vdots \\ \vdots \\ \vdots \\ S_8 \end{matrix} = (0.11 \ 0.14 \ 0.13 \ 0.18 \ 0.15 \ 0.10 \ 0.07) \circ \begin{matrix} 0.295 & 0.339 & 0.285 & 0.060 & 0.031 \\ 0.336 & 0.443 & 0.155 & 0.045 & 0.021 \\ 0.411 & 0.355 & 0.191 & 0.015 & 0.029 \\ 0.362 & 0.311 & 0.185 & 0.102 & 0.040 \\ 0.374 & 0.302 & 0.230 & 0.080 & 0.013 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0.308 & 0.253 & 0.259 & 0.133 & 0.048 \\ 0.377 & 0.314 & 0.223 & 0.065 & 0.021 \\ \vdots & \vdots & \vdots & \vdots & \vdots \end{matrix}$$

$$B = (0.354 \ 0.328 \ 0.215 \ 0.072 \ 0.028)$$

The indicators for the overall Synthetic decision of the practice course are concluded after the indicators of the Fuzzy decision are analyzed and grouped:

$$S = (0.355 \ 0.329 \ 0.216 \ 0.072 \ 0.028)$$

Conclusion

The aims of the study to set up the indicating sets for the overall Synthetic decision, so as to be worked as references for revising adjusting the teaching. The researchers focused on the factors affecting the overall teaching efficacy in engineering practice course. They sorted the factors and grouped them into several decision items. Then, in order to establish the correct and meaningful decision value, they employed the method of the small amount of sample size, which was based on the Fuzzy analysis. Moreover, the membership functions and the indicators for the Fuzzy decision are also made.

- A. From the indicating sets $S_1 \ S_2 \ S_3 \ S_4 \ S_5 \ S_6 \ S_7 \ S_8$ the Synthetic decision results for the main decision items are made. They are: S_1 , Syllabus, is 63.4% (29.5%+33.9%), S_2 , Teaching Materials, is 77.9% (33.6%+44.3%), S_3 , Apparatus and Materials, is 76.6% (41.1%+35.5%), S_4 , Teaching Facilities, is 67.3% (36.2%+31.1%), S_5 , Teaching Methods, is 67.6% (37.4%+30.2%), S_6 , Teaching Environment, is 56% (30.8%+25.3%), S_7 , Teacher Experience And Academic Achievements, is 69.1% (37.7%+31.4%), S_8 , Administration Assistance, is 70.7% (39%+31.2%). From the data, the items of Teaching Materials and Apparatus and Materials are considered to be important in the process of learning by the students related. In this way, these two decision items can possibly affect the efficacy of the teaching. Therefore, they should be strengthened. From S, the grades of 'Very Important' and 'Important' are in the proportion of 68.4% (35.5%+32.9%). This shows its urgent needs for necessary adjustments and revisions.
- B. The results made in this research can provide the authority related with explicit judgements and basis.
- C. The systematic Fuzzy Synthetic decision procedures employed in this research, can be adopted in the teaching evaluation of the courses related.

Table 1
DECISION ITEMS IN THE PRACTICE SYLLABUS QUESTIONNAIRE

Number	Main Items	Sub decision items	Decision Grades				
			V1	V2	V3	V4	V5
1	U1 Syllabus	U11 Concrete aims of the courses					
		U12 Well-planned structures					
		U13 Course links					
		U14 Required practice courses					
		U15 Teaching hours					
2	U2 Teaching Materials	U21 Appropriateness of the text books					
		U22 General contents of the teaching materials					
		U23 Degree of difficulties in the materials					
		U24 Clarity of the contents					
		U25 Renewal and supplement of the Materials					
3	U3 Apparatus And Materials	U31 Apparatus provided					
		U32 Equipment maintenance					
		U33 Tools provided in practice course					
		U34 Appropriateness of the materials					
4	U4 Teaching Facilities	U41 Designs of the laboratory factory					
		U42 Sizes of the laboratory factory					
		U43 Numbers of the laboratory factory					
		U44 Safety and hygiene of the laboratory factory					
		U45 Guidance and maintenance of the laboratory factory					
5	U5 Teaching Methods	U51 Teaching schedules					
		U52 Diversification of the methods					
		U53 Preparation of the teaching equipment					
		U54 Application of the medium					
		U55 Mutual relation between teachers and students					
		U56 Problems handling					
		U57 Supplementary teaching					
6	U6 Teaching Environment	U61 Classroom atmosphere					
		U62 Understanding of the students learning efficacy					
		U63 Contact with the parents					
		U64 Links between the teachers related					
7	U7 Teacher Experience And Academic Achievements	U71 Teachers licenses					
		U72 Specific skills licenses					
		U73 Works and writings related					
		U74 Practical experience					
		U75 Years of teaching					
8	U8 Administration Assistance	U81 Reference books provided					
		U82 Allocation of the expenditure					
		U83 Arrangement of the teaching hours according the teachers special knowledge					
		U84 Guidance of computerized sources					
		U85 Teacher sovereignty on teaching					

V1: very important V2: important V3:general V4: not important V5: not very important

Table 2
TEBLE FOR THE WEIGHTING RATIO NUMBER

Number	Main Items	Weighting ratio	Sub decision items	Weighting ratio
1	U1 Syllabus	0.11	U11 Concrete aims of the courses	0.16
			U12 Well-planned structures	0.11
			U13 Course links	0.25
			U14 Required practice courses	0.28
			U15 Teaching hours	0.20
2	U2 Teaching Materials	0.14	U21 Appropriateness of the text books	0.22
			U22 General contents of thee teaching materials	0.12
			U23 Degree of difficulties in the materials	0.25
			U24 Clarity of the contents	0.26
			U25 Renewal and supplement of the Materials	0.15
3	U3 Apparatus And Materials	0.13	U31 Apparatus provided	0.16
			U32 Equipment maintenance	0.26
			U33 Tools provided in practice course	0.28
			U34 Appropriateness of the materials	0.30
4	U4 Teaching Facilities	0.12	U41 Designs of the laboratory factory	0.15
			U42 Sizes of the laboratory factory	0.24
			U43 Numbers of the laboratory factory	0.26
			U44 Safety and hygiene of the laboratory factory	0.07
			U45 Guidance and maintenance of the laboratory factory	0.28
5	U5 Teaching Methods	0.18	U51 Teaching schedules	0.18
			U52 Diversification of the methods	0.16
			U53 Preparation of the teaching Equipment	0.20
			U54 Application of the medium	0.08
			U55 Mutual relation between teachers and students	0.18
			U56 Problems handling	0.15
			U57 Supplementary teaching	0.05
6	U6 Teaching Environment	0.15	U61 Classroom atmosphere	0.25
			U62 Understanding of the students learning efficacy	0.28
			U63 Contact with the parents	0.23
			U64 Links between the teachers related	0.24
7	U7 Teacher Experience And Academic Achievements	0.10	U71 Teachers licenses	0.14
			U72 Specific skills licenses	0.12
			U73 Works and writings related	0.18
			U74 Practical experience	0.30
			U75 Years of teaching	0.26
8	U8 Administration Assistance	0.07	U81 Reference books provided	0.18
			U82 Allocation of the expenditure	0.28
			U83 Arrangement of the teaching hours according the teachers special knowledge	0.27
			U84 Guidance of computerized sources	0.07
			U85 Teacher sovereignty on teaching	0.20

Table 3
DECISION ITEMS IN THE PRACTICE SYLLABUS QUESTIONNAIRE

Number	Main Items	Sub decision items	Decision Grades				
			V1	V2	V3	V4	V5
1	U1 Syllabus	U11 Concrete aims of the courses	20	30	30	5	0
		U12 Well-planned structures	16	31	24	10	4
		U13 Course links	26	28	20	6	5
		U14 Required practice courses	38	30	16	1	0
		U15 Teaching hours	15	26	32	7	5
2	U2 Teaching Materials	U21 Appropriateness of the text books	30	30	16	6	3
		U22 General contents of the teaching materials	13	25	37	6	4
		U23 Degree of difficulties in the materials	42	32	8	3	0
		U24 Clarity of the contents	15	45	25	0	0
		U25 Renewal and supplement of the Materials	25	36	15	5	4
3	U3 Apparatus And Materials	U31 Apparatus provided	25	32	16	8	4
		U32 Equipment maintenance	39	28	10	7	1
		U33 Tools provided in practice course	30	30	15	5	5
		U34 Appropriateness of the materials	35	26	20	4	0
4	U4 Teaching Facilities	U41 Designs of the laboratory factory	29	30	16	10	0
		U42 Sizes of the laboratory factory	30	25	12	12	6
		U43 Numbers of the laboratory factory	25	26	18	10	6
		U44 Safety and hygiene of the laboratory factory	20	26	25	8	6
		U45 Guidance and maintenance of the laboratory factory	40	26	15	4	0
5	U5 Teaching Methods	U51 Teaching schedules	35	28	12	8	2
		U52 Diversification of the methods	36	25	20	4	0
		U53 Preparation of the teaching equipment	28	26	21	7	3
		U54 Application of the medium	19	24	31	8	3
		U55 Mutual relation between teachers and students	37	25	20	3	0
		U56 Problems handling	30	24	19	10	2
		U57 Supplementary teaching	24	26	20	13	2
6	U6 Teaching Environment	U61 Classroom atmosphere	37	24	18	4	2
		U62 Understanding of the students learning efficacy	35	26	20	4	0
		U63 Contact with the parents	10	14	35	21	5
		U64 Links between the teachers related	20	21	16	18	10
7	U7 Teacher Experience And Academic Achievements	U71 Teachers licenses	20	34	14	10	7
		U72 Specific skills licenses	25	21	27	10	2
		U73 Works and writings related	35	26	20	4	0
		U74 Practical experience	37	25	21	2	0
		U75 Years of teaching	34	28	15	6	2
8	U8 Administration Assistance	U81 Reference books provided	36	24	18	4	3
		U82 Allocation of the expenditure	40	30	10	5	0
		U83 Arrangement of the teaching hours according the teachers special knowledge	38	21	18	8	0
		U84 Guidance of computerized sources	25	27	16	7	10
		U85 Teacher sovereignty on teaching	20	31	20	8	6

V1: very important V2: important V3: general V4: not important V5: not very important

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