Student Preferences of Teachers and Course Importance Using the Analytic Hierarchy Process Model

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***Abstract*—Continuous evaluation of instructors' effectiveness and courses' relevance constitute an important part of the educational Process. In this paper, the Analytic Hierarchy Process (AHP) is used for the Ranking of the following University Courses: Introduction to Computing, Business Statistics and Financial Mathematics. The data for using the AHP model are 482 Greek university students' answers to a questionnaire for the evaluation of the above three courses, with respect to the following three criteria: Teaching Effect of Professor, Effect of a good course book and Easiness for obtaining a pass grade at exams". After applying AHP, we found the weights corresponding to the importance of the courses. The final ranking was the following in descending order: First course: Introduction to Computing, Second course: Business Statistics, and Third course: Financial Mathematics. The Consistency Rations were calculated for all 7 pairwise comparison matrices (PCM) and were all less than 0.1, which is an important requirement for the consistency of the pairwise comparisons. An important finding is that for students, the Communication ability and friendly conduct of a Professor carries more weight that his research activity and that the homework given to students during the course carries more weight than knowledge accumulated from similar previous courses. Finally, students rate higher a book containing many examples presented with clarity than the effort which they make in obtaining the course book.**

***Index Terms*—Analytic Hierarchy Process, Consistency Ratios. Operational Research, Student Preferences, Teaching Effectiveness**

I. Introduction

An important part of teaching assessment is Curriculum evaluation. Every academic management department cannot ignore the findings of empirical research concerning student preferences relative to course evaluation and teacher effectiveness.

A. Evaluation of Courses and Teaching Effectiveness

The evaluation of courses and teaching effectiveness has been a research topic of continuous interest. A great deal of research has been devoted in determining if the teacher's effectiveness of teaching (SET) is a function of the instructor who teaches a course rather than the course that is taught according to Centra [7], Marsh [20] and Marsh and Roche [23]. Of particular interest are the review papers of Feldman [11-14], Zahedi [40], Aleamoni [1], Braskamp et al [4], Marsh [19] and Marsh and Dunkin [21-22], Sun [35], and Blanas [6].

B. The Analytic Hierarchy Process

A multi-criteria method for decision making that uses qualitative and quantitative data is the Analytic Hierarchy Process introduced by Thomas L. Saaty [26-28]. This important decision making technique has been applied to decision problems in many disciplines, such as economic analysis, regional planning and forecasting according to Vargas [38] and Alessio and Ashraf [2]. Important reviews on Analytic Hierarchy Process are: Ho [18], Vaidya and Kumar [37] and Subramanian and Ramanathan [33], and Efron and Tibshirani [8].

C. Applications of the Analytic Hierarchy Process in different fields

We shall review some important papers on AHP which have been published recently. Saaty [28] investigates the considerable qualities of AHP as a method of measurement which uses ratio scales and gives the axioms and some of the crucial theoretical underpinnings of the theory. Saaty [28] pays special attention to departure from consistency of the pairwise comparison matrix (PCM), because the consistency is necessary for the validity of the AHP. The AHP method uses pairwise comparison matrices (PCM) for making decisions. Considerable research has been devoted for testing the consistency of the (PCM). The interested reader is referred to the paper of Ergu et al [9].

In a research paper, Tsinidou et al [36], the authors attempt to obtain a clearer picture of evaluations of quality determinants in Greek Higher Education as they are perceived by the students. The authors use the AHP for finding the relative importance weights of quality determinants that influence the educational process in Greek

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Higher Education. These quality determinants are the following: "Academic Staff", "Administration Services", "Library Services", "Curriculum Structure", "Location", "Infrastructure" and "Career Prospects". For the criterion of quality: "Academic Staff" ,the authors suggest the following sub-criteria: "Academic Qualifications", "Professional Experience", "Communication Skills", "Friendliness", "Business Links" and "Research Activity".

The sub-criteria for "Curriculum Structure" are the following: "Course content/Book", "Educational Material", "Structure of Courses", "Course Structure info", "Elective Courses", "Laboratories" and "Weekly Timetable". A point which needs further investigation is that the students who have answered the questionnaire in the above paper, believe that the sub-criterion "Content of the Course" is not very attractive compared to the other sub-criteria of "curriculum structure", according to Tsinidou et al [36].

In Education the AHP has been applied in selecting University Faculty, according to Grandzol [16] and Saaty et al [32]. In Marketing, the AHP has been used for evaluating and comparing website usability according to Presley and Fellows [24]. In a paper by Altuntas et al [3], the AHP is used for measuring hospital service quality.

In an important review paper, Sipahi and Timor [34] categorize the applications of the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) in various fields such as environmental Management and Agriculture, Energy Studies, Transportation and Construction Industries, Education, Logistics, Research and Development, Telecommunication Industry, Banking and Finance, Urban Development, Defense Industry and Military, Government, Marketing, Tourism, Archaeology, Mining and Auditing. During the period 2005-2009, 600 papers related to AHP and ANP have been published [17, 34].

D. Decision Problems in which the Analytic Hierarchy Process can be applied

According to Forman and Gass [15], the decision circumstances in which the AHP can be applied include: a. Choice. The selection of one alternative from a given group of alternatives, usually where there are multiple decision criteria involved. b. Ranking. Ordering a set of alternatives from most to least desirable. c. Prioritization. Determining the relative advantages of members of a set of alternatives, as opposed to selecting a single one or merely ranking them. d. Resource allocation. Distributing resources among a set of alternatives [5]. e. Benchmarking. Comparing the operations and processes in one's own organization with those of other best-of-breed organizations. f. Quality Management. Dealing with the different points of view of quality and quality improvement. g. Conflict Resolution. Settling Disputes between Companies or groups of workers with apparently incompatible goals or positions [30-31].

E. Aim

In this paper, we apply the Analytic Hierarchy Process (AHP) in order to rank three courses "Introduction to Computing (INTRODUC._TO_COMPUTING)", "Business Statistics (BUSINESS_STATISTICS)" and "Financial Mathematics (FINANCIAL_MATHS)", with respect to the three criteria: "Teaching Effect of Professor (EFPROF)", "Effect of a good Course Book (CBOOK)" and "Easiness for Getting a Pass Grade at Exams (GPEXAM)".

II. AHP METHODOLOGY

A. Setting of the Overall Goal, the Pairwise Comparison Matrix (PCM), called A for the three Criteria and the Evaluation Scale [39]

In general, a hierarchical model of some social problem might be one that descends from an overall goal (focus), down to criteria, down further to sub-criteria which are subdivisions of the criteria and ,finally , to the alternatives from which one must make the choice. In our case, we have:

a. OVERALL GOAL: the choice by the students of one University Course with respect to three criteria (CHCOURSE).

b. CRITERIA: "Teaching Effect of Professor (EFPROF)", "Effect of a good Course Book (CBOOK)" and "Easiness for obtaining a Pass Grade at Exams (GPEXAM)".

c. ALTERNATIVES: "Introduction to Computing (INTRODUC._TO_COMPUTING)", "Business Statistics (BUSINESS_STATISTICS)" and "Financial Mathematics (FINANCIAL_MATHS)".

d. The subcategories of criterion: "Teaching Effect of Professor (EFPROF)", are: "Academic Qualifications (ACQUAL)", "Previous Professional Experience (PEXPER)", "Communication Ability (COMMNCA)", "Friendly Conduct (FRIENDC)", and "Research Activity (RACTIV)".

e. The subcategories of criterion: "Effect of a good Course Book (CBOOK)" are: "Clear presentation of contents of Course (CLEARC)", "Inclusion of many Examples (EXAMPLE)", and "Easy Access of Course book (ABOOK)".

f. The subcategories of criterion: "Easiness of Obtaining a Pass Grade at Exams (GPEXAM)" are: "Avoidance of Stress by good preparation for exams (ASTRESS)", "Obtaining a partial Pass mark by Continuous Assignments during the Course (CASSIGN)", and "Existence of knowledge about the subject from Previous Courses (PCOURSE)".

To obtain the weights for the three criteria or objectives, we follow the exposition of Analytic Hierarchy Process [25, 39]. The first step is to set up pairwise comparison Matrices (PCM) for the 3 courses compared with respect to each of the three criteria, in the same manner, as we formed the (PCM) matrix A. We call them:

B (Comparison with respect to criterion (EFPROF),
C (Comparison with respect to criterion (CBOOK)
D (Comparison with respect to criterion (GPEXAM)

B. Obtaining Students' Evaluations through a Questionnaire

The entries in the pairwise comparison Matrices A, B, C, and D are the mean values of the answers to questions contained in a structured Questionnaire which has been

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distributed to 482 students at the University of Athens and at the Technological Educational Institute of Athens who have been taught the three courses.

C. The Four Pairwise Comparison Matrices

From the answers to the Questionnaires, we obtain the following Pairwise Comparison Matrices:

$$A=\begin{bmatrix} 1 & 0.500 & 0.700 \\ 2.000 & 1 & 0.600 \\ 1.428 & 1.666 & 1 \end{bmatrix}$$

$$B=\begin{bmatrix} 1 & 4.048 & 4.142 \\ 0.247 & 1 & 0.500 \\ 0.241 & 2.000 & 1 \end{bmatrix}$$

$$C=\begin{bmatrix} 1 & 3.633 & 3.629 \\ 0.275 & 1 & 3.383 \\ 0.275 & 0.295 & 1 \end{bmatrix}$$

$$D=\begin{bmatrix} 1 & 4.235 & 4.358 \\ 0.236 & 1 & 0.450 \\ 0.229 & 2.222 & 1 \end{bmatrix}$$

For the final ranking of the three Courses, we obtain the following weights according to detailed spreadsheet instructions in [25] and [39]:

$$W_{11}=0.651,\ W_{21}=0.120,\ W_{31}=0.240$$

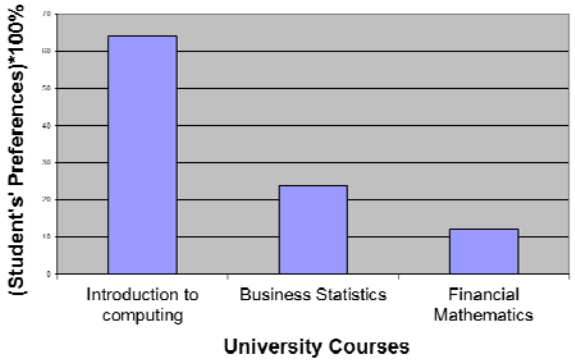

Fig. 1. Ranking of the three Courses, according to students' preferences by AHP.

D. Calculation of the Consistency Ratios for Each Pairwise Comparison Matrix

A matrix is said to be consistent if it holds: $\alpha_{ij}*\alpha_{jk}=\alpha_{ik}$, for every i, j and k. We must calculate the Consistency Ratios for every pairwise comparison matrix and these Ratios [26], must not exceed appreciably 0.10, otherwise we must revise some of our judgments.

The Consistency Ratio is given by:

$$CR=\frac{(\lambda_{max}-n)}{(n-1)*r_n}$$

where λ_{max} is the maximum eigenvalue given by the average Consistency Measure for all alternatives [25, 39], n is the number of alternatives for this problem (n=3) and r_n is a random number given by Saaty [26], for n=3, the number of alternatives r_n=0.58. The Consistency Ratios calculated in the same manner for the matrices A, B, C, and D, using Microsoft Excel [10, 25, 39] are given below:

TABLE I
CONSISTENCY RATIOS FOR THE PAIRWISE COMPARISON MATRICES

Pairwise Comparison Matrix	Consistency Ratio	Pairwise Comparison Matrix	Consistency Ratio
A	0.070	C	0.082
B	0.050	D	0.066

Note, that every Consistency Ratio is less than 0.10, according to the guidelines of Saaty [26]. Hence, the judgments of the evaluators are fairly consistent.

E. The Pairwise Comparison Matrices for the Sub-criteria of Each Criterion

Now, we turn our attention to the pairwise comparisons of the sub-criteria corresponding to each criterion. We form the following pairwise matrix E, for the sub-criteria of the first criterion: "Effectiveness of teaching Professor" described in paragraph (d) of Section (II).

$E=$

	ACQUAL	*PEXPER*	*COMMNCA*	*FRIENDC*	*RACTIV*
ACQUAL	1	3,626	3	3.662	3.400
PEXPER	0.275	1	3.455	3.586	3.347
COMMNCA	0.333	0.289	1	3.111	2.333
FRIENDC	0.273	0.278	0.321	1	0.900
RACTIV	0.294	0.298	0.428	1.111	1

We next find the following weights, summarized graphically in the following graph and the Consistency Ratio for matrix E:

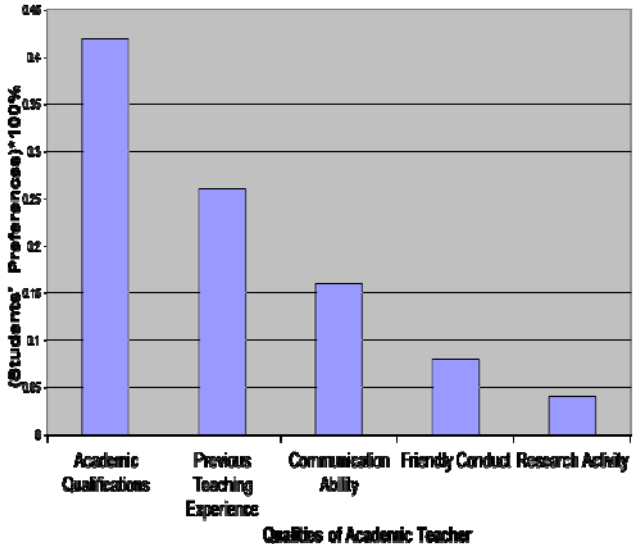

Fig. 2. Ranking of qualities for Academic Teacher. Consistency Ratio= 0.081.

We can see that the highest weight of "importance" is assigned to "Academic Qualifications" whereas the lowest

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weight of "importance" is assigned to "Research Activity." We note that "Friendly Conduct" and "Communication Ability" have higher degree of "importance" than "Research Activity", in the opinion of students.

Similarly to criterion "Effectiveness of Professor (EFPROF)", we construct the following table with the Rankings of the sub-criteria for criteria: CBOOK and GPEXAM.

TABLE II
STUDENTS' PREFERENCES FOR THE TWO CRITERIA: CBOOK AND GPEXAM

	CLEARC	EXAMPLE	ABOOK
CBOOK	0.590	0.260	0.150
	ASTRESS	CASSIGN	PCOURSE
GPEXAM	0.650	0.250	0.090

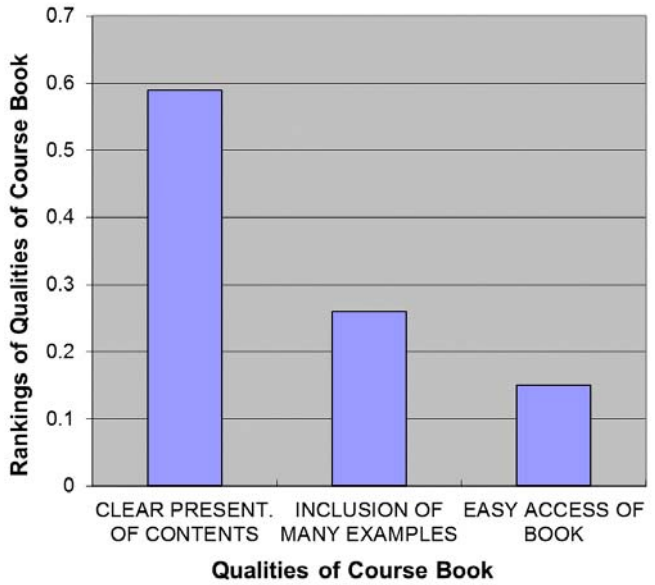

Fig. 3. Ranking of qualities of a good course Book, according to students' preferences.

We note that the students rate "Obtaining a partial Pass mark by Continuous Assignments during the Course" higher than "Existence of knowledge about the subject from Previous Courses" and "Inclusion of many Examples" higher than "Easy access of Course book".

III. CONCLUSION

The AHP is a powerful method which can be used for the evaluation and choice of Courses and Selection of University Faculty. Apparently, the AHP can be applied to many diverse fields, such as Engineering, Planning, Military, Marketing, Economics, Conflict Resolution, Environmental Management, Research and Development and many more.

According to the opinions of the group of students who have completed a Questionnaire, "Teaching Effectiveness of the Professor" is a criterion with sub-criteria of highest rating the "Academic Qualifications" and of lowest rating the "Research Activity". The sub-criterion "Ability of Communication" is of higher rating than the sub-criterion "Research Activity". The following questions are to be investigated: (b1) if there was a different random sample of students, the degree of the "importance" of Teaching Effectiveness could be different? (b2) If the Courses in consideration were offered online would the preferences of the students be different? (b3) Which are the preferences of the students towards Courses which are taught at laboratory Sessions, using Computer packages?

An important task is to develop Psychological instruments such that people's feelings can be adequately represented by numerical scales. The results of AHP can be compared with similar results from other Decision approaches, such as Expected Monetary Reward decisions and Optimization algorithms.

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