Analysis of Students' Preferences for Teachers Based on Performance Attributes in Higher Education

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***Abstract* – Faculty evaluation is widely used not only for the appraisal of their performance, but also for curriculum innovation and development. There are many techniques to perform faculty evaluation. But these techniques do not address all the factors essential for evaluating a faculty. These evaluations are subjective in nature and found to be controversial as students' expectations vary. This hinders the main motive of faculty evaluation. To overcome this problem, there is a need to identify a suitable method to perform faculty evaluation. In this paper, the Conjoint Analysis, a mathematical statistics technique is used to analyze the major aspects that the students are expecting from their faculty. This technique increases the fairness in the appraisal process so that teaching can be made fun and effective. This research is a novel attempt that applies conjoint analysis to identify the major aspects of teaching in students' perspective. The proposed idea can be adapted to any domain where the customers' choice is valued particularly in Cloud computing services.**

***Keywords* – Students Evaluation of Teaching (SET), Performance Attributes, Conjoint Analysis, Relative preference analysis, Part-worth utilities.**

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1. Introduction

The level of interest the students show on a particular subject is based on the liking they have towards the faculty. The student assessment of teachers in higher education includes various parameters. The response to these parameters varies from student to student. So, evaluating a faculty through the evaluation techniques is always a challenging task. There are various approaches available to perform faculty evaluation. One of the most popular approaches is the Students' Evaluations of Teaching (SET). Many schools and colleges are using the SET evaluation to assess their faculty. But the major issue with the SET is that many parameters are not included in this evaluation. A study found that, since the parameters vary from student to student, evaluating creates numerous problems and hence researchers advocated to other approaches like in-class observations by administrators [1]. But the problem with this approach is that this approach was resource-intensive and it requires administrators' time and effort to attend classes and give reviews.

It is identified that web sites such as RateMyProfessors.com provide and collect teaching evaluations through an online evaluation system, and such sites reduce the resources and time required for colleges to conduct the SET and process the SET results [2]. But again, the problem with this website is sampling errors and rater bias. It is believed that students' review is more important than administrators reviewing the faculty [3]. But the problem with students reviewing faculty is that it can have a negative effect on teachers [4]. This method of evaluation needs to be handled very carefully. It should be made sure that students' evaluation should be fair and faculties should be able to accept the requirements of the students. Researchers are currently working on a new approach for the faculty evaluation that can replace the SET. There is a need for a detailed study to include parameters that are missing out in the SET. It is understood that there will be no politics involved in the evaluation [5].

In this work, a new technique is proposed that uses Conjoint Analysis to evaluate the teaching performance. The proposed system not only solves the problems involved in the SET but also it is cost-effective to implement. Another advantage is that the proposed system removes the negative impacts that the SET can instill. Also, this method aims to evaluate the faculty in a fair manner.

1.1 Conjoint Analysis

Conjoint Analysis or Stated Preference Analysis is a survey-based statistical technique which is used to determine individual's preferences. This technique originated from mathematical psychology. It is mostly used in marketing, product management and operations research [6]. To illustrate Conjoint Analysis, let us assume that a student has gone to attend an interview. The HR says that he cannot offer the role student wanted as the HR finds the student to be more capable for another role with higher pay. Which role will the student choose is the question? In this example, attribute one is the role that the student wanted and attribute two is the pay. When he chooses the first option, it will show that he put higher emphasis on his passion. Choosing the second option will reveal he gave higher emphasis for higher pay, that is, money. His preference for one of the alternatives will reveal the 'part-worth utilities' i.e., the preference for individual parameter. In Conjoint Analysis, the part-worth utilities of individual attributes, in this case, 'passion' and 'higher pay' are calculated based on the selection or ranking for the defined set of combinations of attribute values [7].

The rest of the paper is organized as follows: Section 2 is the consolidation of the literature on Conjoint Analysis in computing environments; Section 3 presents the theoretical framework of Conjoint Analysis and proposed methodological framework of implementation; Section 4 presents how Conjoint Analysis is implemented with the collected sample set of data; Section 5 presents the results and discussion; Section 6 is the conclusion with the future possibilities of extension.

2. Related works

This section discusses different contributions on Conjoint Analysis in education system. Student evaluations of teaching fail to address many of the essential factors such as new course preparations, teaching in larger classes, inconvenient class times, etc. This hinders the curriculum transaction and also leads to an ineffective way of discharging the duties by the faculty members. To overcome this, the work demonstrates how Conjoint Analysis can be used to create a model of teaching evaluation that simultaneously considers many aspects of teaching performance and increases fairness in the appraisal process [2]. It is found that the mathematical model is unbiased, ethical, reliable, and systematic and provides a clear idea in deciding the standards and also provides transparency in the evaluation process.

The mathematical statistical model does not solve the problem of human judgement in evaluating a scholar but it provides clarity and objectivity in the evaluation process [5]. Even with a single respondent, Conjoint Analysis can generate a research-scoring model because of the within-subject of the conjoint design.

Conjoint Analysis accounts explicitly for heterogeneity that is arising from the students' preferences and applies it to form a comprehensive faculty evaluation [8]. Conjoint Analysis has better discriminator power than the conventional approach to the faculty evaluation. It also offers a chance for a detailed analysis of students' preferences. When research is carried out separately, the aggregate of the preferences of students' can be obtained using Conjoint Analysis and this data can also be used to calculate the weighted score of each teacher. This makes Conjoint Analysis more powerful and accurate than the conventional approach.

It is found out that many researches are being carried on the student evaluation of faculty, but there is no proper conclusion on the validity of the process [9]. This brought the need to do a research on the issue whether the evaluations done by the students are related to what they study. This led to the result that the students think grades are related to the evaluations that they give for both the subject and the instructor. This research found that almost everywhere there is a negative association between rigor and the SET. It is identified that Conjoint Analysis can be used to investigate the use of instruments in student course evaluation by universities, which is tied up with the American Assembly of Collegiate Schools of Business [10].

It is concluded that all the analysis techniques are being used to make teaching fun and effective. Twelve strategies are found out which will make teaching the way the students want. They are student ratings, peer ratings, self-evaluation, videos, student interviews, alumni ratings, employer ratings, administrator ratings, teaching scholarship, teaching awards, learning outcome measures and teaching portfolios [11]. This work found out that many tools are being used to evaluate faculty, one such tool is RateMyProfessors.com. This website reveals the students' mindset on faculty evaluation. Nowadays, as students are involved more in social media, their thought process on the faculties and the subject they handle are influenced by web communication and social media networking. This is where sites like RateMyProfessors.com become more useful [12].

Conjoint Analysis is used in the analysis for more than thirty years now. In these thirty years, through the interplay of theoretical contribution and the practical applications, Conjoint Analysis is growing as researchers and practitioners learn useful things from this technique every time they use [13].

3. Theoretical framework & Methodology of implementation

The objective of this work is to implement the statistical technique Conjoint Analysis to evaluate a faculty which identifies the most influencing attribute from a group of attributes. Conjoint Analysis is used as the technique to identify how much each parameter contributes to the overall evaluation and also for individual respondents. The data are collected through a questionnaire which is answered by students and Conjoint Analysis is applied to the collected data. The results give the weighted level of individual that students prefer the most with the faculty. The preference of the parameters is computed as a percentage, which is presented graphically for clear understanding. Conjoint Analysis may give the feeling that it is an unusual technique to be used. But this is the most appropriate statistical approach applied to evaluate faculty performance [6].

Conjoint Analysis is applied to the data that are collected from individuals. In this research, it is applied to the data that are collected from students. The attributes like subject content, discipline, class control personal relationship, personality etc., of the teachers are taken as the performance attributes for evaluation. The combination of performance attributes forms a single record called profile. These profiles are given to the respondents for ranking. Once the responds are collected, the linear additive model is used to analyze the responses. Figure 1. presents the proposed methodology implemented in this work.

Phase 1: Data Collection
1. Criteria Selection 2. Data Collection
Phase 2: Evaluation Process by Conjoint Analysis
1: Criteria and Criteria Selection 2: Experimental Design construction 3: Data Collection 4: Parameter Estimation 5: Compute individual part-worth utilities 6: Calculate preferences level 7: Segment Level of part-worth utilities
Phase 3: Result Analysis
1. Weighted score by an individual student 2. Teachers' weighted score in segments overall teachers' score

Figure 1. Designed methodology

According to this method, the best of the results will be obtained by computing the part-worths of the attributes. Hence the respondent *a's* predicted conjoint utility for the profile *b* is given by equation 1 as follows:

$$U_{ab} = \sum_{c=1}^{C} \sum_{l=1}^{L_c} \beta_{acl}\, x_{bcl} + \epsilon_{ab}, a =, . A\,; b = 1..B \qquad (1)$$

where *a* is the number of respondents; *b* is the number of profiles; *c* is the number of attributes; L_c is the number of levels of attribute *c*. β_{acl} is respondent *a's* utility with respect to level l of attribute c. x_{bcl} is such a (0,1) variable that it equals 1 if profile b has attribute *c* at level l, otherwise it equals 0. ε_{ab} is a stochastic error term. A is the individual respondent and B is the individual profile. The parameter β_{acl} is calculated using regression analysis. *β (beta)* coefficients are also known as part-worth utilities. The *β* coefficients can be used to establish the following: first, the value of the coefficients represents the amount of effect that an attribute has on the entire utility i.e., the larger the coefficient, the greater the effect. Second, part-worths can be used in preference-based segmentation.

Respondents who give similar responses for a level are grouped together. Third, part-worths can be used to calculate the relative importance of each attribute. The relative importance that a^{th} respondent assigned to the attribute c is denoted as W_{ac} given in equation 2 as follows:

$$\frac{\max\{\beta_{ac1}\beta_{ac2},..,\beta_{acL_c}\} - \min\{\beta_{ac1}\beta_{ac2},..,\beta_{acL_c}\}}{\sum_{c=1}^{C}(\max\{\beta_{ac1}\beta_{ac2},..,\beta_{acL_c}\} - \min\{\beta_{ac1}\beta_{ac2},..,\beta_{acL_c}\})} \qquad (2)$$

The average of these impedances is taken in order to group the similar responses. Thus, the importance of attribute *c* in segment *s* is given by the equation 3 as follows:

$$W_{cs} = \frac{1}{A_s} \sum_{a=1}^{A_s} W_{ac}\,, \quad c = 1, \dots\dots, C\,; s = 1, \dots, S \qquad (3)$$

where *As* is the number of respondents from the segment *s*. Part-worth utilities can be used to find the overall utility values for all possible combinations of attribute levels by inserting the part-worth values in equation 1.

There are certain steps that have to be followed to apply Conjoint Analysis on the data of faculty evaluation. The first step is to decide the criteria based on which the students are going to evaluate the faculty. This selection needs to be very careful because the result majorly depends on it. After fixing the criteria, Conjoint Analysis has to be applied.

4. Applying Conjoint Analysis

The first step in the methodology is the evaluation of the faculty by the students. This phase involves further sub processes. The first and foremost task is to define the set of attributes. The attributes should be chosen in such a way that they cover all the essential parameters needed to be considered for the performance of the faculty. Also, it should be modifiable. Once the attributes are finalized, the number of levels for each attribute should be chosen. In this work the attributes and levels chosen are shown in Table 1.

Table 1. Attributes and levels

Factor	***Attribute 1***	***Attribute 2***	***Attribute 3***
Subject Proficiency (A)	Raises problems and issues relevant to the subject (A_1)	Presents the latest developments in areas under discussion (A_2)	Simplifies difficult material at an appropriate pace with thorough subject knowledge (A_3)
Discipline (B)	Use the time effectively (B_1)	Regular and punctual to the class (B_2)	-
Student – Faculty Relationship (C)	Relates to students as individuals (C_1)	Approachable to students during and outside the class (C_2)	Gives constructive feedback to the students (C_3)

The range of these levels should be broad and if necessary, some attributes can be considered to be at the same level too. The next step is to identify combinations of attributes and levels have to be obtained. Table 2. presents the different combinations.

Table 2. Possible Combinations of attributes

Combination Number	*Combination*
Model 01	$A_1B_1C_1$
Model 02	$A_1B_1C_2$
Model 03	$A_1B_1C_3$
Model 04	$A_1B_2C_1$
Model 05	$A_1B_2C_2$
Model 06	$A_1B_2C_3$
Model 07	$A_2B_1C_1$
Model 08	$A_2B_1C_2$
Model 09	$A_2B_1C_3$
Model 10	$A_2B_2C_1$
Model 11	$A_2B_2C_2$
Model 12	$A_2B_2C_3$
Model 13	$A_3B_1C_1$
Model 14	$A_3B_1C_2$
Model 15	$A_3B_1C_3$
Model 16	$A_3B_2C_1$
Model 17	$A_3B_2C_2$
Model 18	$A_3B_2C_3$

Conjoint Analysis is a mathematical statistical model which uses the levels with constant values -1 and 1, that is, B1 is coded as -1 and B2 is coded as 1. Once the attributes and levels are fixed, data has to be collected which will be the next step. Here data are collected through a Questionnaire. This work has used www.surveymonkey.com to make the survey process. The questionnaire is circulated to 300 students of Department of Computer Science, CHRIST (Deemed to be University), India. The questionnaire contains all the possible combinations and the students are supposed to specify their preferences as 'rank' between 1 to 16 because there are 18 combinations. That is, the most preferred combination is ranked as 1 and the least preferred combination is ranked as 18. After the data is collected from all the students, individual responses are sorted out to evaluate individual preferences. The ranks of the combinations are computed with the mean from 300 samples and are shown in Table 3. below:

Table 3: Rank of the combinations

Combination Name	*Rank*
$A_1B_1C_1$	08
$A_1B_1C_2$	03
$A_1B_1C_3$	02
$A_1B_2C_1$	05
$A_1B_2C_2$	06
$A_1B_2C_3$	04
$A_2B_1C_1$	01
$A_2B_1C_2$	11
$A_2B_1C_3$	07
$A_2B_2C_1$	15
$A_2B_2C_2$	12
$A_2B_2C_3$	10
$A_3B_1C_1$	14
$A_3B_1C_2$	13
$A_3B_1C_3$	09
$A_3B_2C_1$	17
$A_3B_2C_2$	18

The attributes are ranked by the participants (students) and then part-worth utilities have to be calculated. Linear regression is used to calculate part-

worth utilities using the rank identified. Ranking is calculated by multiplying part-worth of attribute 1 with the attribute level added to the product part-worth of attribute 2 and attribute level added with the product part-worth of attribute 3 and attribute level added with a constant value. Once the ranking is done, part-worth utilities should be calculated. To calculate this, the main attribute of each parameter should be obtained and the average of them has to be calculated. Next step is to calculate the 'relative preference'. The formula to calculate relative preference is given in equation 4 as follows:

$$\text{Relative Preference} = \frac{\text{Individual Preference}}{\text{Total Preference}} \quad (4)$$

The relative preferences are calculated and are given in the Table 4. as follows:

Table 4: Preference level of each attribute by the students

Performance attributes	***Preference***
Subject Proficiency	61%
Discipline	24%
Student-Faculty Relationship	15%

5. Results and Discussion

Conjoint Analysis establishes the important parameters involved in the process of faculty evaluation. The importance of each parameter based on students' evaluation is calculated using this technique and is presented in Figure 2.

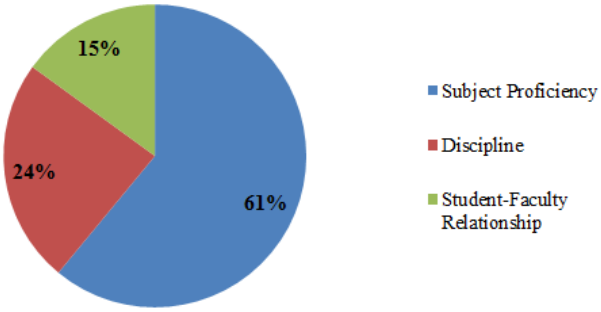

Figure 2. Preference of the performance attributes of the teachers at the higher education level

The output obtained using conjoint analysis is represented in percentage. All the parameters that constitute faculty evaluation are split into proportions based on their importance. The percentage split-off represents the preference of each attribute. It is clear from the above chart that subject proficiency is the most preferred attribute by higher education students. It means that students value faculties that are more proficient in their subjects than the faculties with the other attributes. The result that this work shows is not a constant one. This might change in a period of time due to various reasons. Therefore, it is suggestible to conduct the evaluation process frequently to track the requirements of the students from time to time.

6. Conclusion

This paper has used Conjoint Analysis for faculty evaluation and the results derived were more accurate. The Conjoint Analysis, a statistical technique, is used not only for faculty evaluation but also to determine the students' preferences and importance towards the various aspects of teaching. The proposed method in this paper is novel and more powerful than the conventional approaches for faculty evaluation. Also, this approach removes the controversies that arise in the SET and also it is easy to include the attributes. Even though this technique fails to disregard the error arising due to human judgement, it provides clarity about the evaluation process which is lacking in a few conventional approaches.

In future, this idea can be extended for the student evaluation by the faculty; therefore faculty can elucidate what faculty expects from students. Also, this method can be used to find out the different teaching techniques that a faculty can follow to provide efficient and quality teaching. By using this technique, the quality of education and the relationship between a faculty and a student can be improved which will make the learning process more interesting and constructive.

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