Exploiting Faculty Evaluation Forms to Improve Teaching Quality: An Analytical Review

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***Abstract*—The mission of educating and providing highly qualified human resources for nation requires universities to endeavour to improve the quality of teaching and learning. The feedbacks of students about faculty performance have become valuable sources of information for universities in the process. There have been several studies of the exploitation of useful knowledge from faculty evaluation forms. In this paper, we analyse and compare the different approaches of those previous studies. From the analysis and results obtained by exploiting faculty evaluation forms in Ton Duc Thang University's online evaluation system, we propose two new problems and methods for the extraction of knowledge in order to improve the quality of teaching and support stakeholders in making more effective and efficient decisions.**

Keywords—student feedback; faculty performance; faculty evaluation form; teaching performance evaluation

I. INTRODUCTION

In the context of the knowledge economy, the quality of education has become the competitive advantage of each nation. Having been responsible for providing people with sufficient knowledge to participate in the labour market, universities must constantly improve the quality of teaching and learning. The construction of evaluation standards as a basis for quality improvement is an essential part of this process. There are many strategies to measure faculty performance including: student ratings, peer ratings, self-evaluation, videos, student interviews, exit and alumni ratings, employer ratings, administrator ratings, teaching scholarships, teaching awards, learning outcome measures and teaching portfolio [2]. Among these strategies, student ratings are considered as a common evaluation tool in many universities throughout the world [4].

In this paper, we carry out a literature review on the exploitation of knowledge from faculty evaluation forms to improve the quality of teaching and support stakeholders' decisions. For example, administrators can make decision in recruitment, salary increase, and task assignments; students can choose appropriate courses and instructors; instructors can identify their strengths and weaknesses, and attempt to improve the quality of teaching. Based on the previous studies, we analyse evaluation forms in the online faculty evaluation system of Ton Duc Thang University. We also propose some new directions of exploiting the forms.

The rest of the paper is organized as follows: Section II presents studies of exploiting faculty evaluation forms using statistical methods, machine learning methods, or a combination of both. Section III compares various approaches in tabular form. Section IV presents the results obtained from experimental data. Section V presents our new research proposals. Section VI draws the conclusion.

II. STUDIES OF EXPLOITING FACULTY EVALUATION FORMS

To the best of our knowledge, there are a few studies of exploiting faculty evaluation forms to improve teaching quality and help stakeholders to make decisions. This section is divided into three parts according to the method applied to solve the problem.

A. Exploiting faculty evaluation forms using statistical methods

In [12], evaluation forms were analysed to identify the determining factors of faculty performance and course satisfaction. The empirical data were collected from an online MBA program in 2007, with a total of 4,589 forms. Each form consists of 21 evaluation factors divided into three categories: personal attributes, learner facilitation, and quality of feedback. The overall ratings consist of overall performance of the instructor and overall satisfaction of the course. Factor analysis was used to verify the dimensionality of the categories. Regression analysis was applied to identify the determining factors of faculty performance and course satisfaction. The result shows that personal attributes group had the most important impact. This study proposed factors which should be focused to improve teaching quality and satisfaction with the course.

B. Exploiting faculty evaluation forms using machine learning methods

In [8], evaluation forms were analysed to identify the determining factors of faculty performance. The empirical data were collected from a faculty evaluation system in spring semester 2008. Improved Apriori algorithm was applied to find the association rules with the form $zb_x \rightarrow zp$ (zb_x is an evaluation factor and zp is faculty performance). Unlike the traditional Apriori algorithm, in this algorithm, after each loop finds the frequent item-sets, the properties of database are filtered to reduce the amount of data scanned in the next loop. The experimental result shows that teaching content and

teaching attitude had the most important impact on faculty performance.

In [9], the authors identified the evaluation factors and appropriate data mining methods to evaluate faculty performance, thereby supporting the formulation of policies and the use of human resources. The study identified 77 factors which influence faculty performance. The empirical data include information about 50 Information Technology instructors of a university. K-means algorithm was applied to cluster instructors based on performance. The experimental result shows that there were two clusters: Cluster 1 consisted of the instructors with unique performance values while cluster 2 consisted of the instructors with performance values which appear more than once. Classification and Regression Tree algorithm (C&R Tree) was used to classify instructors according to the values of factors. In their future work, they will apply data mining methods for instructors in each discipline. In addition, they will find patterns of faculty performance to support the prediction and compare the changes in performance over time.

In [11], the authors classified evaluation forms based on the categories of faculty performance and found the relationship among evaluation factors. The empirical data were divided into four groups according to faculty performance: very good, good, satisfactory, and poor. The evaluation factors consist of subject knowledge, teaching with new aids, motivating self and students, communication skills, class control, punctuality and regularity, knowledge beyond syllabus, and aggregate. The traditional Apriori algorithm was applied to find the relationship among factors. In the future, the authors will consider the changes in the behaviours of instructors and investigate other evaluation strategies such as administrator ratings, peer ratings and self-evaluation. In addition, they will compare the evaluation results about management courses in various institutes.

In [3], the authors collected data from a personnel management system and an educational evaluation system. The traditional Apriori algorithm was applied to find the relationship between the personal information of instructors namely sex, age, title, education and overall rating; the relationship between evaluation factors namely teaching attitude, teaching ability, teaching content, teaching organization, teaching method and teaching effect. The study proposed factors which should be focused to improve the quality of teaching based on rules with high confidence.

In [5], evaluation forms were analysed to identify the determining factors of faculty performance. The empirical data were collected from an online evaluation system. Each form consists of evaluation factors divided into four categories: subject knowledge, teaching skills and assessment methods, behaviour toward students, and communication skills. Model tree algorithms namely REP and M5P were applied to build the tree to classify faculty performance based on evaluation factors. This tree was then used to identify the determining factors of faculty performance. In particular, the factor at the root of the tree is the determining factor because it has the ability to split the data into groups with the lowest entropy. Less important factors are at lower levels of the tree. The experimental results show that REP algorithm achieved higher accuracy and spent less time building the tree than M5P algorithm. Both algorithms came to the same result: subject knowledge was the determining factor of faculty performance. The study proposed factors which should be focused to improve teaching quality and provided useful knowledge to support managers in making decisions.

C. *Exploiting faculty evaluation forms using both statistical methods and machine learning methods*

In [10], the authors used statistical and data mining methods to evaluate faculty performance. There were 3,000 forms with 77 evaluation factors. ZeroR algorithm was used to classify instructors according to performance. Expectation maximization (EM) algorithm was applied to cluster the data based on the value of factors. The result shows that there were 14 clusters. Each cluster had four levels of performance evaluation: very good, good, satisfactory, and poor. The percentage of rating was calculated for each cluster and average performance was then calculated for each aforementioned level. This value was more accurate than the value applying the traditional statistical method because the impact of factors in each cluster was considered. In addition, the OLAP statistical tool was used to extract the trends of faculty performance. Analysing the dependence in the data by mining association rules will be their future work.

In [1], evaluation forms were analysed to identify the determining factors of faculty performance. The empirical data were collected from the evaluation of Management Information Systems department's courses (undergraduate and graduate) at Bogazici University during the period from 2004 to 2009 and some other instructor and course characteristics drawn from the Student Evaluation of Teaching research. Factor analysis was applied to identify independent factors influencing faculty performance in order to reduce the number of factors considered. The result is that a new factor called the attitude of the instructor was derived from taking the average of the other seven factors. Stepwise regression and decision tree methods (CHAID, CART algorithms) were used to identify the determining factors of faculty performance. The experimental result of stepwise regression method shows that five factors consisting of the attitudes of the instructor, the attendance of the student, the ratio of students filled the questionnaire to the class size, the instructor is a part-time labourer and the workload of the course explained 85% of the variation of faculty performance. Two algorithms CHAID and CART created different trees. The factors in each tree were considered as the set of the most important factors to faculty performance. Both trees had the same factor at their roots: the attitude of the instructor. In the future, the authors will apply the proposed method to other departments to examine the determining factors of faculty performance in each department and all departments.

In [6], the authors proposed a new approach based on conjoint analysis method to evaluate faculty performance. Evaluation factors consist of clear and understandable presentation, methodical and systematic approach, tempo of lecturers, preparedness for a lecture, the accuracy of arrival to the lecture, encouraging students to participate in classes,

informing students about their work, considering student comments and answering questions, availability (through individual teacher/student meetings or via e-mail). This study shows that the importance of each evaluation factor was different for each student. Regression analysis was used to estimate the weight each student attached to each factor. The results obtained from evaluation forms will then be combined with these weights to evaluate faculty performance. In addition, they clustered students based on the similarity in evaluation form using k-means method and then analysed the faculty performance in each group. Overall scores and ranks of instructors obtained from the proposed method had significantly fewer duplicates than the conventional approach.

In [7], evaluation forms were analysed to identify the determining factors of faculty performance. The empirical data were collected from the graduates of a faculty at an engineering university in three years. Classification methods consisting of four algorithms: Naïve Bayes, ID3, CART, LAD Tree were used to build faculty performance classification model based on evaluation factors. These factors include: teacher name, speed of delivery, content arrangement, presentation, communication, knowledge, content delivery, explanation power, doubts clearing, discussion of problems, overall completion of course and regularity, students attendance, and result. The authors then used built model to analyse the impact of each factor on faculty performance through statistical tests: Chi-square test, Info Gain test, Gain Ratio test. The experimental results show that Naïve Bayes algorithm had the highest classification accuracy. The statistical tests came to the same result: content arrangement was the determining factor of faculty performance.

III. Comparative Study

Comparative study of methods exploiting faculty evaluation forms is given in TABLE 1.

IV. Experiment and Results

We have collected empirical data from the online faculty evaluation system of Ton Duc Thang University in the second semester 2013-2014. Each student is required to fill in a faculty evaluation form for each course before viewing the result of the final exam. The total number of evaluation forms is 116,576. The faculty evaluation form consists of 17 questions or 17 factors. We use a Likert scale with intervals of 1 to 5 as follows.

5 = Strongly Satisfied,

4 = Satisfied,

3 = Neither,

2 = Dissatisfied,

1 = Strongly Dissatisfied

We use backward linear regression method and SPSS software to analyse the impact of each factor on the overall rating in the university. The results obtained are shown in TABLE 2.

The factors are divided into five groups: course content, teaching method, study guide, the responsibility of the instructor, the behaviours of the instructor. The forms also contain one section to record the additional comments of students and an overall rating. We calculate the average of each group and analyse the impact of each group on the overall rating in the university. The results are shown in TABLE 3.

When we conduct similar analyses for each of 15 departments, we obtain consistent results: the factor “friendly to students” and the group “behaviours” have the most important impact on the overall rating. The next important factors and groups may vary with different departments. We present results obtained in three departments representing the faculty of engineering, the faculty of social sciences and the faculty of economics. The impact of each factor and the impact of each group on the overall rating in the department of information technology are shown in TABLE 4 and TABLE 5 respectively. TABLE 6 and TABLE 7 show the impact of each factor and the impact of each group on the overall rating in the department of linguistics while TABLE 8 and TABLE 9 present the corresponding results in the department of business management.

It can be seen from these results that the attitude of the instructor is the determining factor of students’ satisfaction. The instructors should be aware of this problem in order to improve not only the satisfaction but also the learning performance of students.

V. Problems and Proposed Methods

The previous studies of exploiting faculty evaluation forms focus on identifying the determining factors of faculty performance. The proposed methods consist of regression analysis, statistical tests, association rules mining, decision tree, and stepwise regression tree. The statistical methods such as regression analysis and statistical tests are suitable for identifying important factors that influence faculty performance as they can rank the impact of factors according to impact coefficients. On the other hand, the machine learning method such as decision tree can only identify the most important factor which is the factor at the root of the tree. There may be several factors appearing at one level of the tree so we cannot rank the impact of these factors. Furthermore, we can obtain various trees depending on the algorithm and pruning method applied, which results in various sets of important factors. However, the machine learning method such as association rules mining can find the relationship among the factors while this cannot be conducted by statistical methods. The combination of statistical methods and machine learning methods can utilise the benefits of both.

In general, the exploitation of useful knowledge from evaluation forms to improve the quality of teaching and support decision-making is still limited. The results obtained by analysing our empirical data just identify factor and group which have the most important impact on the overall rating. We have not utilised machine learning and other statistical methods to exploit data effectively. Therefore, we propose to consider a number of problems and the following solutions.

TABLE I. COMPARATIVE STUDY OF VARIOUS EXPLOITATION METHODS

Category	Year	Author	Problem solved	Proposed method	Result
Statistical methods	2008	[A. Wong]	Identify the determining factors of faculty performance and course satisfaction	- Factor analysis - Regression analysis	- Verify the dimensionality of evaluation categories - Personal attributes group was the determining factor of faculty performance and course satisfaction
Machine learning methods	2009	[P. Qingxian]	Identify the determining factors of faculty performance	Improved Apriori	Teaching content and teaching attitude had the most important impact on faculty performance
	2010	[C. Singh]	Find appropriate data mining methods to evaluate faculty performance	- K-means - C&R Tree	- There were two clusters: Cluster 1 consisted of instructors with unique performance values while Cluster 2 consisted of instructors with performance values which appear more than once - Classify instructors according to the values of factors
	2011	[C. Singh]	Classify faculty evaluation forms based on the categories of faculty performance and find the relationship among evaluation factors	- A clustering algorithm in Weka - Apriori	- The empirical data were divided into 4 groups according to faculty performance: very good, good, satisfactory, and poor - Find the relationship among factors to improve teaching quality
	2012	[S. Geng]	Find the relationship between the personal information of instructors and overall rating; the relationship between evaluation factors and teaching effect	Apriori	Improve the quality of teaching based on rules with high confidence
	2012	[S. A. Kumar]	Identify the determining factors of faculty performance	Model tree (REP, M5P)	- REP algorithm achieved higher accuracy and spent less time building the tree than M5P algorithm - Subject knowledge was the determining factor of faculty performance
Combined methods	2011	[C. Singh]	Use statistical and data mining methods to evaluate faculty performance	- ZeroR - EM - OLAP tool	- Classify instructors according to performance - Calculate the average performance for four levels of performance evaluation: very good, good, satisfactory, and poor - Extract the trends of faculty performance
	2011	[B. Badur]	Identify the determining factors of faculty performance	- Factor analysis - Stepwise regression tree - Decision tree (CHAID, CART)	- Identify independent factors influencing the faculty performance - Stepwise regression tree identified five factors explaining 85% of the variation of faculty performance - The factors in CHAID and CART trees were the set of the most important factors to faculty performance - The attitude of the instructor is the determining factor of faculty performance in both algorithms
	2013	[M. Kuzmanovic]	Propose a new approach to evaluate faculty performance	- Regression analysis - Conjoint analysis - K-means	Calculate overall weighted score, overall weighted rank; weighted score and weighted rank in each segment for each instructor
	2013	[A. K. Pal]	Identify the determining factors of faculty performance	- Classification method (Naïve Bayes, ID3, CARD, LAD Tree) - Statistical tests: Chi-square test, Info Gain test, Gain Ratio test	- Naïve Bayes algorithm had the highest classification accuracy - Content arrangement was the determining factor of faculty performance in statistical tests

TABLE II. IMPACT COEFFICIENTS OF FACTORS IN THE UNIVERSITY

Factor	Impact coefficient
1.1. Present objectives, requirements, and the need of the course clearly	0.07
1.2. Lectures meet the core content of the course	0.04
1.3. The contents of lectures have links with other courses	0.03
1.4. There are many exercises and practical situations to support lectures	0.05
2.1. Flexible and understandable teaching method	0.06
2.2. Create exciting and lively lectures	0.05
2.3. Encourage students to participate in classes	0.05
3.1. Encourage students to do research to improve knowledge	0.05
3.2. Instruct students to seek resources for self-study	0.03
3.3. Instruct students to apply theory to practice	0.05
4.1. Ready to answer students' questions (even outside school hours)	0.05
4.2. Inspire students	0.05
4.3. Monitor the attendance of students	0.03
4.4. Use the school hours effectively	0.06
5.1. Punctuality and regularity	0.03
5.2. A good example for students	0.05
5.3. Friendly to students	0.22

TABLE III. IMPACT COEFFICIENTS OF GROUPS IN THE UNIVERSITY

Group	Impact coefficient
1. Course content	0.18
2. Teaching method	0.17
3. Study guide	0.13
4. Responsibility	0.19
5. Behaviours	0.28

TABLE IV. IMPACT COEFFICIENTS OF FACTORS IN THE DEPARTMENT OF INFORMATION TECHNOLOGY

Factor	Impact coefficient
1.1. Present objectives, requirements, and the need of the course clearly	0.07
1.2. Lectures meet the core content of the course	0.06
1.3. The contents of lectures have links with other courses	0.03
1.4. There are many exercises and practical situations to support lectures	0.00
2.1. Flexible and understandable teaching method	0.08
2.2. Create exciting and lively lectures	0.05
2.3. Encourage students to participate in classes	0.08
3.1. Encourage students to do research to improve knowledge	0.04
3.2. Instruct students to seek resources for self-study	0.03
3.3. Instruct students to apply theory to practice	0.06
4.1. Ready to answer students' questions (even outside school hours)	0.04
4.2. Inspire students	0.06
4.3. Monitor the attendance of students	0.03
4.4. Use the school hours effectively	0.05
5.1. Punctuality and regularity	0.04
5.2. A good example for students	0.05
5.3. Friendly to students	0.24

TABLE V. IMPACT COEFFICIENTS OF GROUPS IN THE DEPARTMENT OF INFORMATION TECHNOLOGY

Group	Impact coefficient
1. Course content	0.17
2. Teaching method	0.21
3. Study guide	0.12
4. Responsibility	0.17
5. Behaviours	0.29

TABLE VI. IMPACT COEFFICIENTS OF FACTORS IN THE DEPARTMENT OF LINGUISTICS

Factor	Impact coefficient
1.1. Present objectives, requirements, and the need of the course clearly	0.07
1.2. Lectures meet the core content of the course	0.05
1.3. The contents of lectures have links with other courses	0.03
1.4. There are many exercises and practical situations to support lectures	0.05
2.1. Flexible and understandable teaching method	0.07
2.2. Create exciting and lively lectures	0.07
2.3. Encourage students to participate in classes	0.06
3.1. Encourage students to do research to improve knowledge	0.06
3.2. Instruct students to seek resources for self-study	0.02
3.3. Instruct students to apply theory to practice	0.03
4.1. Ready to answer students' questions (even outside school hours)	0.04
4.2. Inspire students	0.06
4.3. Monitor the attendance of students	0.03
4.4. Use the school hours effectively	0.07
5.1. Punctuality and regularity	0.00
5.2. A good example for students	0.06
5.3. Friendly to students	0.22

TABLE VII. IMPACT COEFFICIENTS OF GROUPS IN THE DEPARTMENT OF LINGUISTICS

Group	Impact coefficient
1. Course content	0.19
2. Teaching method	0.21
3. Study guide	0.10
4. Responsibility	0.18
5. Behaviours	0.27

TABLE VIII. IMPACT COEFFICIENTS OF FACTORS IN THE DEPARTMENT OF BUSINESS MANAGEMENT

Factor	Impact coefficient
1.1. Present objectives, requirements, and the need of the course clearly	0.04
1.2. Lectures meet the core content of the course	0.05
1.3. The contents of lectures have links with other courses	0.04
1.4. There are many exercises and practical situations to support lectures	0.05
2.1. Flexible and understandable teaching method	0.07
2.2. Create exciting and lively lectures	0.06
2.3. Encourage students to participate in classes	0.04
3.1. Encourage students to do research to improve knowledge	0.06
3.2. Instruct students to seek resources for self-study	0.02
3.3. Instruct students to apply theory to practice	0.08
4.1. Ready to answer students' questions (even outside school hours)	0.06
4.2. Inspire students	0.05

4.3. Monitor the attendance of students	0.03
4.4. Use the school hours effectively	0.06
5.1. Punctuality and regularity	0.04
5.2. A good example for students	0.05
5.3. Friendly to students	0.21

TABLE IX. IMPACT COEFFICIENTS OF GROUPS IN THE DEPARTMENT OF BUSINESS MANAGEMENT

Group	Impact coefficient
1. Course content	0.18
2. Teaching method	0.17
3. Study guide	0.14
4. Responsibility	0.18
5. Behaviours	0.28

A. Problem 1: Analyse the characteristics of instructors

Each evaluation form can be considered as a student's perspective on the characteristics of an instructor. The mean values of each instructor's characteristics are calculated from the evaluation forms of all students about that instructor. The results obtained show overall ratings of students on the characteristics of instructors. Clustering methods are used to exploit valuable knowledge about the characteristics of instructors such as the strengths and weaknesses of instructors in the university, each faculty (e.g. faculty of engineering) or each department (e.g. department of information technology); the characteristics of instructors belonging to the group appreciated by students in the whole university, in each faculty or each department. Clusters obtained from those methods are then evaluated by using relevant cluster validity measures. The result provides an overview of the human resources to help making decision such as appropriate task assignments and recruitment. Time series data mining methods are used to examine the changes in overall ratings and the characteristics of instructors over time. They also discover patterns of faculty performance and the characteristics of instructors, and detect anomalies to make timely adjustments. Natural language processing methods support to analyse the comments of students in order to extract valuable knowledge. For example, they can make a summary of comments for each instructor by collecting and analysing all the related comments.

B. Problem 2: Predict the faculty performance

The previous studies have built models by using decision tree to identify the factors that have the most important impact on faculty performance instead of supporting the prediction. The prediction of faculty performance by using factors outside the evaluation form is significant because it can support the administrators in the recruitment process. Therefore, we propose to build a model in order to predict the faculty performance.

Given a set of evaluation factors $A = \{A_1, A_2 \dots A_n\}$, P is faculty performance.

The model learned is $X \Rightarrow P$ with $X \subset A$.

In the pre-processing step, we remove potentially unreliable faculty evaluation forms such as forms with the same ratings for all questions and forms of students who give the same ratings for all instructors. In addition, we also attach weights to the evaluation forms. The students' forms with better study results will have higher weights because they are hardworking and wise students. We then collect data about faculty performance and select external factors such as qualifications, teaching experience, age, gender, appearance to build training and testing dataset. We conduct several experiments on various classification methods to select the method with the highest accuracy.

VI. CONCLUSION

In the paper, we have analysed previous studies of exploiting faculty evaluation forms. In general, these studies only focus on a few problems such as identifying factors that have the most important impact on faculty performance or finding the relationship among the factors. Statistical methods applied on the data from the online faculty evaluation system of Ton Duc Thang University provide consistent results for each department and the whole university: the attitude of the instructor is the determining factor of students' satisfaction. We have proposed two problems: analysing the characteristics of instructors and predicting the faculty performance. In the future, we will carry out proposed solutions in order to improve the quality of teaching and support administrators in making decisions.

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