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Integration and Innovation of English Language,
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Department of English Language, Literature and Linguistics,
Providence University, Taiwan
Edited by
Yu-Chuan Joni Chao
Wen-Chi Vivian Wu
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Application of DEA on English Writing Learning Performance

Bernard Montoneri, Providence University, Taiwan
Chia-Chi Lee, National Taipei College of Business, Taiwan
Tyrone T. Lin, Shio-Ling Huang, National Dong Hwa University, Taiwan

Abstract

This paper aims at exploring the quantitative learning performance of English as a Second Language (ESL) learners in a university of Taiwan. Freshmen following English writing courses from the academic year 2004 to 2006 are chosen as the research object. This paper adopts data envelopment analysis (DEA) to design a learning performance mechanism by using input indicators (the preparation of teaching contents and the teaching skills) having a significant impact on output indicators (the fair grading and the students’ learning performance). The empirical results will reveal that the teachers are suggested to announce the grading criteria early in the semester to help the students follow the rules and obtain guidance before preparing the exam. In addition, the teachers’ over explanation of the writing course contents could also decrease the students’ concentration during the class: they are advised to give students more opportunities to do exercises or to revise the course contents, so as to achieve the optimal performance of the outputs and enhance the students’ learning performance.

Keywords: data enveloped analysis (DEA), English as a Second Language (ESL), learning performance

1. Introduction

Higher education is becoming more and more competitive in Taiwan because the government budget has not increased as much as the number of higher education institutions. Moreover, Taiwan has the lowest fertility rate in the world, and as a result, even if higher education is now universal, the number of students is decreasing dramatically. The Ministry of Education Taiwan expects educational institutions to maintain a certain level of quality and has initiated a system of performance evaluation for every school. This system is based upon self-evaluation reports, and accompanied by peer reviews or site visits. Among the many evaluated items, one of the most fundamental is the student’s learning performance.

This paper applies data envelopment analysis (DEA) in order to explore the key indicators contributing to students’ learning performance for English freshmen writing courses in a university of Taiwan. Writing courses are known to be difficult to teach and the students struggle to write
correctly in a foreign language. As a result, the learning motivation and satisfaction cannot easily reach the expectations of both teachers and students. The influence of cross-culture and of the teachers’ domain knowledge can impact positively the students’ learning performance. The English language is a valuable communication tool, but a deeper understanding of Western culture, including history, literature, and arts, combined with a keen sense of observation and sharp logic, is necessary for students who will graduate from the university as English majors.

The remainder of the paper is organized as followed: the literature review presents some academic papers in relation with our paper. The methodology and chosen key items explain the DEA method and the important input and output items discussed in the paper. The followed section presents the obtained primary numerical results based on the empirical data. The final paragraph draws the conclusions and implications.

2. Literature review

Data envelopment analysis (DEA) can be used to analyze students’ learning performance and to provide information about how to improve both students and teaching performance. Ahn et al. (1989) and Glass et al. (1998) have used DEA to assess the efficiency of higher education institutions. Some studies have also measured efficiency at the departmental level: Madden et al. (1997), Johnes and Johnes (1993), and Colbert et al. (2000).

Fu and Huang (2009) collected different performance indicators, including college graduate performance in the job market after graduation and student satisfaction with regard to the school environment and curriculum. They used an output-oriented BCC type of DEA model to evaluate of the relative resource use efficiency of schools for school administrators.

McGowan and Graham (2009) studied the factors contributing to improved teaching at Brigham Young University (BYU), a private church-sponsored university. They determined that the top four factors leading to improvement were active/practical learning (providing real-world experiences and in-class discussions), teacher/student interactions (knowing each student personally), clear expectations/learning outcomes (having high and clear expectations for the students), and faculty preparation.

In the field of Teaching English as a Second Language (TESL), various studies have tried to improve students’ learning performance. Barcelos and Kalaja (2003) demonstrated that teachers’ and students’ beliefs about second language acquisition are experiential, dynamic, socially constructed, and changeable. Wang et al. (2009) have proposed a decision tree algorithm,
based on students’ personal characteristics and performance, to discover the most adaptive learning sequences in the field of TESL.

Clinton and Kohlmeyer (2005) have investigated the effect of group quizzes on accounting students’ performance and motivation to learn. He and Shi (2008) have explored the perceptions and experiences of international students in Western Canada on the Test of Written English and the English Language Proficiency Index. Sakai (2008) analyzed Japanese-speaking university students’ oral performance in English and Hsu (2010) proposes a web-based interactive speaking improvement system for English as a Second Language learners, using fuzzy matching.

3. Methodology and choice of inputs and outputs

Performance evaluation is widely applied in many fields to enhance management performance, to change strategy, or to increase productivity. Enterprises and institutions can use various assessment methods, such as structural equation modeling (SEM), stochastic frontier analysis (SFA), multi-level modeling (MLM), or data envelopment analysis (DEA) to clarify the performance of people, equipment resources, and operation procedures. The main objectives of this evaluation are to better allocate limited resources and to make optimal strategies and decisions in time.

Students who enter university are different every year: they have different background and characteristics. The courses of English writing are taught by many teachers providing different teaching efforts. Therefore, the learning results are not easy to predict. In this paper, we would like to design a learning performance mechanism which is composed by the DEA model, the results treating, and the results interpreting. This study aims at identifying the main input indicators (the preparation of teaching contents and the teaching skill) having a significant impact on the output indicators (the fair grading and the learning performance). The input and output indicators describing this type of learning performance should better be quantitative, so as to be compared to different evaluated units. DEA method is particularly suitable and reliable for this type of study.

3.1. DEA Model and Charnes-Cooper-Rhodes (CCR) model

The domain of inquiry of DEA method is a set of available performance indicators on the evaluated units, called decision making units (DMUs), which receive multiple inputs and produce multiple outputs (Lin et al., 2009; Lee, 2009). DEA can help indicate the relative efficiency of each DMU within a sample (Samoilenko and Osei-Bryson, 2008).
Charnes et al. (1978) converted the concept of multiple inputs and multiple outputs into single virtual input and output by linear combination. They estimated efficiency frontier by the ratio of two linear combinations and measured the relative efficiency of each DMU. The constant returns to scale (CRS) represents the fact that the DMU’s inputs and outputs reach a state of optimal configuration, without the need of any adjustment from the inputs and outputs: it is the optimal performance every unit is supposed to reach. This method is called “Charnes-Cooper-Rhodes (CCR) model or CCR model”. According to Lin et al. (2009) and Lee (2009), the efficiency value of CCR model corresponds to the overall technical efficiency of an evaluated unit. If the efficiency value equals 1, the evaluated unit is efficient (optimal performance); if the efficiency value is less than 1, the evaluated unit needs some improvement.

3.2. Definition of DMU

This paper adopts DEA to build up the evaluation of learning performance mechanism and to perform the efficiency evaluations of freshmen students of one department of a university in Taiwan from the academic year 2004 to 2006. They follow the same training program of English writing for one semester. A total of 50 classes are selected as the decision-making units (DMUs), that is, the evaluated units. They are named from D1 to D50. The learning performance of the DMUs will be interpreted by analyzing the input items and the output items. In this paper, the DMUs are the classes that have this course of writing.

3.3. Selection of input and output items

The specification of the inputs and outputs is a crucial first step in DEA. The empirical analysis will help to know the correlation between teaching characteristics and learning performance. Four items for the evaluation model are rated from 1 (very unsatisfied) to 5 (very satisfied) by students and are chosen as follows:

Input dimension:

I1. The preparation of teaching contents: it could reflect the degree of teachers’ professional knowledge for the preparation of teaching materials.

I2. The teaching skill: it refers to the clarification of the course of English writing which reflects the level of students’ assimilation.

Output dimension:

O1. The fair grading: it indicates whether teacher’s grading is fair.

O2. The students’ learning performance: it indicates students’ knowledge acquisition after a semester of English writing training.
All the data acquired are fed into the learning performance mechanism designed for this research. The numerical results are treated and then interpreted in the following sections.

3.4. Correlation analysis of input and output items

The correlation of the input items and output items is verified by statistics method to understand whether the principle of Isotonicity is satisfied. This study uses the Pearson correlation coefficient test. The higher the Pearson correlation coefficient is, the closer the relationship between two variables is; the lower the correlation coefficient is, the lower the correlation between two variables is. Generally speaking, a Pearson correlation coefficient of 0.8 or above indicates a very high correlation; a value of 0.6 to 0.8 indicates a high correlation; a value of 0.2 to 0.4 indicates a low correlation; a value inferior to 0.2 indicates an extremely low correlation or no correlation. Table 1 is listing the input (I) and output (O) items: I1 represents the preparation of teaching contents and I2 the teaching skill; O1 represents fair grading and O2 the learning performance. The correlation coefficients among these 4 items are all above 0.9 with significant levels at 1%. This shows a very high degree of correlation. Therefore, the principle of Isotonicity is satisfied. In addition, the variance inflation factor (VIF) check is effectuated to measure the impact of collinearity among the input items and the output items. The result shows that the VIF values all satisfy the norm (VIF<10); that is, the VIF value inferior to 10 means that there is no highly collinearity problem between the input items or between the output items, and that the highly correlation problem does not exist in our study. Hence, the input and output items chosen in this study can not replace one another; each item is representative of the evaluation of learning performance.

Table 1. Correlation coefficients between input and output items.

<table>
<thead>
<tr>
<th>Outputs</th>
<th>I1 (Preparation of teaching contents)</th>
<th>I2 (Teaching skill)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1 (Fair grading)</td>
<td>0.961***</td>
<td>0.939***</td>
</tr>
<tr>
<td>O2 (Learning performance)</td>
<td>0.936***</td>
<td>0.908***</td>
</tr>
</tbody>
</table>

Note: *** denotes significant levels at 1%.

4. Primary empirical results

In this paper, Frontier Analyst is used to analyze the learning performance. The results of numerical analysis can help to provide suggestions to teachers and students on how to better use limited teaching
and learning resources. Can the students’ learning efforts and teachers’ teaching efforts reach the expected performance?

4.1. Efficiency analysis of learning performance

Table 2 is listing the CCR score. It refers to the overall technical efficiency in the CCR model for 50 DMUs, named from D1 to D50. The average efficiency of 50 DMUs is 0.962. The overall technical efficiency of the DMUs D6, D22, D37, D41 and D49, which represent 10% of the evaluated units, have the best performance with a value of 1. Their CCR Score are all on the Frontier curve. In other words, these 5 DMUs do not need any improvement in the input items or in the output items because they have reached the optimal state. The other DMUs with CCR score (overall technical efficiency) inferior to 1 will need further improvement or adjustment in the input or output items. For example, D23 has the lowest overall technical efficiency, 0.906. It could come from the preparation of teaching contents, teaching skill, fair grading, or learning performance.

Table 2. Overall technical efficiency of evaluated units under the CCR model

<table>
<thead>
<tr>
<th>DMU name</th>
<th>CCR Score</th>
<th>DMU name</th>
<th>CCR Score</th>
<th>DMU name</th>
<th>CCR Score</th>
<th>DMU name</th>
<th>CCR Score</th>
<th>DMU name</th>
<th>CCR Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>0.965</td>
<td>D11</td>
<td>0.969</td>
<td>D21</td>
<td>0.967</td>
<td>D31</td>
<td>0.978</td>
<td>D41</td>
<td>1.000</td>
</tr>
<tr>
<td>D2</td>
<td>0.973</td>
<td>D12</td>
<td>0.984</td>
<td>D22</td>
<td>1.000</td>
<td>D32</td>
<td>0.941</td>
<td>D42</td>
<td>0.971</td>
</tr>
<tr>
<td>D3</td>
<td>0.968</td>
<td>D13</td>
<td>0.913</td>
<td>D23</td>
<td>0.906</td>
<td>D33</td>
<td>0.932</td>
<td>D43</td>
<td>0.940</td>
</tr>
<tr>
<td>D4</td>
<td>0.967</td>
<td>D14</td>
<td>0.912</td>
<td>D24</td>
<td>0.983</td>
<td>D34</td>
<td>0.942</td>
<td>D44</td>
<td>0.953</td>
</tr>
<tr>
<td>D5</td>
<td>0.980</td>
<td>D15</td>
<td>0.961</td>
<td>D25</td>
<td>0.999</td>
<td>D35</td>
<td>0.941</td>
<td>D45</td>
<td>0.995</td>
</tr>
<tr>
<td>D6</td>
<td>1.000</td>
<td>D16</td>
<td>0.985</td>
<td>D26</td>
<td>0.934</td>
<td>D36</td>
<td>0.938</td>
<td>D46</td>
<td>0.968</td>
</tr>
<tr>
<td>D7</td>
<td>0.947</td>
<td>D17</td>
<td>0.963</td>
<td>D27</td>
<td>0.942</td>
<td>D37</td>
<td>1.000</td>
<td>D47</td>
<td>0.953</td>
</tr>
<tr>
<td>D8</td>
<td>0.926</td>
<td>D18</td>
<td>0.943</td>
<td>D28</td>
<td>0.951</td>
<td>D38</td>
<td>0.987</td>
<td>D48</td>
<td>0.951</td>
</tr>
<tr>
<td>D9</td>
<td>0.949</td>
<td>D19</td>
<td>0.948</td>
<td>D29</td>
<td>0.997</td>
<td>D39</td>
<td>0.938</td>
<td>D49</td>
<td>1.000</td>
</tr>
<tr>
<td>D10</td>
<td>0.978</td>
<td>D20</td>
<td>0.971</td>
<td>D30</td>
<td>0.963</td>
<td>D40</td>
<td>0.966</td>
<td>D50</td>
<td>0.948</td>
</tr>
</tbody>
</table>

Average CCR Score is 0.962

5. Conclusion and recommendations

The DEA evaluation method has been widely applied in various industries and is proved to be quite reliable. It has also been applied to assess the efficiency of higher education institutions. This paper used DEA to explore the key indicators contributing to students’ learning performance for English freshmen writing courses in a university of Taiwan. The empirical results could show that teachers should announce the grading criteria early in the semester. It could help the students follow the rules and obtain guidance before preparing the exam. Furthermore, when the teachers’ over explain the writing course contents, it can decrease the students’ concentration during the class. The students should be given more
opportunities to do exercises or to revise the course contents. This evaluation approach of learning performance can be employed to other branches of learning, even to corporate employee training.

Writing courses are difficult to teach and students often feel uncomfortable writing essays, especially in a foreign language. If the teaching content is too difficult for the students to assimilate, they will probably lose their motivation to learn and give up. The atmosphere during the class and the relationship between the teacher and the students is important. It is part of “teaching skills”. This type of course is not just about correcting grammatical or syntactical mistakes, but also to have a deeper understanding of Western culture, including history, literature, and arts, combined with a keen sense of observation and sharp logic. It is of the utmost importance to increase the learning performance of the students who want to graduate from a university as English majors.

References


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發行人：趙毓銓

編著者：趙毓銓(Yu-Chuan Joni Chao)、呂文琪(Wen-Chi Vivian Wu)

地址：43301 臺中縣沙鹿鎮中和路 200 號

電話：04-26328001 轉 12021, 12024-12026

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