TEACHING OPERATIONS MANAGEMENT TO LAWYERS

F. Salas-Molina, M. Vercher-Ferrandiz, D. Pla-Santamaria, A. Garcia-Bernabeu

Universitat Politècnica de València (SPAIN)

Abstract

This paper deals with a problem present in most Master in Business Administration (MBA) classrooms. This problem is the heterogeneity of students and their backgrounds. Different backgrounds pose a challenge to teachers that require the use of quantitative techniques such as optimization within an Operations Management subject. Engineers and other students with mathematical training probably get bored if the level is too low. On the contrary, Lawyers and other students without technical background usually find contents cumbersome. This paper aims to find a compromise between the heterogeneity of backgrounds and the fulfilment of learning objectives for students of Operations Management in an MBA. To this end, we propose a methodology to support the selection of teaching methods from a multiobjective perspective. The results derived from this methodology enable professors to consider their particular preferences and to integrate important decision-making principles by selecting the appropriate distance function to an ideal point that acts as a reference.

Keywords: Heterogeneity, quantitative skills, teaching methods, multicriteria.

1 INTRODUCTION

Heterogeneity of students is a challenge in many learning environments [1,2]. However, heterogeneity presents many dimensions such as gender, racial groups, cultural background and skills. In this paper, we focus on the skills dimension to deal with the problem of different backgrounds within students enrolled in MBA courses. More precisely, we consider two groups of students: 1) those with enough background of quantitative abilities such as engineers and other students with mathematical training; and 2) those with not enough mathematical background. Since an MBA can be considered a general or non-specialized training, both groups of students are likely to share classrooms in most training centers. For ease of naming, we will hereafter use the term engineers when referring to the first group and the term lawyers to identify the second group.

Most MBA degrees are addressed to recent graduates, but also to people with some professional experience. We can reasonably assume that all of them want to develop a professional career in the field of business management. To this end, MBA contents include topics that are present in many business' daily work such as Strategic Management, Economics, Finance and Accounting, Marketing, Human Resources Management, Entrepreneurship and Operations Management. Some of these subjects require the use of quantitative methods for decision-making. In the case of Operations Management [3], several quantitative methods are used to select the best decisions among all the alternatives that are feasible. This procedure is called optimization and it is at the core of most decision-making models in Operations Management such as inventory theory, linear programming and project management.

Different backgrounds pose a challenge to teachers of subjects with quantitative techniques as a central part of the table of contents. Mathematical models are frequently more abstract than those concepts than can be expressed in conventional language. Indeed, teachers can explain Operations Management contents in English, Spanish, but also in mathematical language. Engineers (in our context, maths lovers) with enough mathematical training will probably get bored if the level of this language is too low. On the contrary, Lawyers (in our context, maths haters) and other students without technical background will find this language too difficult to understand. Clearly, this issue is not new and different authors have proposed alternative ways to solve the problem of heterogeneity of skills. Gamification [1,6], levelling seminars or individualized teaching [4], the use of electronic contents [5], and focusing on the learning process [7] are some examples. Summarizing, we can find alternative ways of the combined process of teaching-learning that can deal with the heterogeneity of skills problem. However, there is a lack of a methodology to rank alternatives or to select a subset of teaching methods that can deployed according to an objective criterion.

To solve this problem, we here propose a set of logical steps select teaching methods from a multiobjective perspective. More precisely, we follow the approach of evaluating teaching activities in

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terms of two interesting attributes, namely, quantitative intensity (QI) and concept amplitude (CA). Following with our example of engineers and lawyers, teaching methods with a high QI are those typical of engineering subjects such as mathematical modelling, formal reasoning, problem solving, algorithms description. On the other hand, teaching methods with a large CA are those typical of law subjects such as wide descriptions using common language, case studies, historical reviews, definitions, classifications, quiz games, video lectures and possibly many others.

If QI and CA are desired attributes for teaching methods in MBA subjects such as Operations Management, we can think of a teaching method (if any) with both maximum QI and maximum CA. This ideal method is likely to be non-existent or, at least, very difficult to design in practice because it will perfectly achieve the desired attributes. However, it is a good reference point to assess the ability of alternative methods to fulfil the set of attributes under consideration. As a result, we here propose a compromise programming approach [8] in which distances to this ideal point with maximum QI and maximum CA are used to select the optimal teaching methods mix subject to restrictions of available time for preparing activities and according to teacher preferences. We must say that different attributes and a set of three or more attributes can be used with the same methodology.

The results derived from this methodology enable professors to consider their particular preferences and to integrate important decision-making principles by selecting the appropriate distance function to an ideal point that acts as a reference. The proposed method can be extended to consider as many desirable attributes of teaching activities as needed and it also allows to consider possible constraints such as diversity and effort in the preparation of materials.

2 METHODOLOGY

In this section, we describe in Section 2.1 an assessment method to evaluate any teaching method in terms of two or more criteria. For illustrative purposes, we will focus on QI and CA as desired attributes to adjust teaching methods to the skills students within the background range between engineers and lawyers. In Section 2.2 we introduce the compromise programming method as a sound technique within the field of multiple criteria decision making to find a balance between QI and CA.

2.1 Evaluating teaching methods

The first step in our proposal is an assessment of the attributes QI and CA for each of the teaching methods under consideration within the context of any subject of interest. This step clearly depends on the subjective belief of teachers, but we consider this fact an advantage rather than a drawback because, at this stage, teachers are incorporating their preferences based on their knowledge and experience. Furthermore, the initial selection of teaching methods is also subjective choice that ultimately depends on the abilities and even on the creativity of teachers. Recall that our context is the subject of Operations Management within an MBA course with a heterogeneous blend of backgrounds that we label as engineers and lawyers.

As an illustrative example, let us consider the set of teaching methods summarized in Table 1. The first teaching method in this table is mathematical modelling. A course of Operations Management usually includes the Economic Order Quantity (EOQ) model to derive the optimum quantity that must be ordered when the remaining stock of a given product is nearly zero. This EOQ model requires the use of a cost function including the fixed cost per order and the holding cost per unit of product and unit of time. The analytical derivation of the EOQ model to obtain the optimum quantity requires the use of basic techniques of cost functions differentiation. One may decide to introduce the solution without showing its origin, but this alternative may provoke in the students the feeling that numerical expressions appear without proper justification. This situation is likely to be present when presenting many other mathematical models and, thus, mathematical modelling represents an example of a teaching method with high QI.

On the other hand, consider teaching based on the case study method. This method is broadly used in MBA courses and it consists of the use of a text to introduce and describe a topic of interest. After reading the text, some questions are formulated and discussed in groups to foster the participation of students. As an example, consider the paper by Porter and Kramer [9] in which they propose the concept of shared value with a new perspective to the role and objectives to be pursued by companies. Rather than focusing on the economic goals, companies should consider additional goals where both the social and the environmental aspects of business actions are also key elements. The implications of this paper on the operations management of most companies at a strategic level are remarkable. Thus, discussing how operations management can contribute to create shared value is an interesting teaching/learning activity. This case study method is an example of a teaching method with high CA. No numerical content is required, and it is a good method to thoroughly introduce and discuss concepts.

In an MBA context, engineers are not going to find problems in mathematical modelling, but it is likely that lawyers experiment some difficulties. On the contrary, lawyers will usually feel comfortable with study cases and engineers will consider hard to go through long readings. As a result, teachers must find a balance between QI and CA of alternative teaching methods. To this end, teachers need to evaluate methods in terms of QI and CA using a numerical scale, e.g., within the range 0-10. In Table 1, we show an example of this evaluation. In addition to the QI and CA assessment, we include the preparation effort associated to each teaching method since we can reasonably assume that no all methods require the same preparation time. Even though this preparation effort will ultimately depend of each teacher, we can assume that definition of concepts or historical reviews require less preparation than mathematical modelling or algorithm implementation. This preparation effort measured in hour of dedication per each hour of teaching implies a constraint of the problem.

Table 1. Teaching methods evaluation.

Teaching method	***Quantitative Intensity (QI)***	***Concept Amplitude (CA)***
Mathematical modelling	10	2
Problem solving	8	5
Graphs construction	8	3
Algorithm implementation	9	4
Project development	5	7
Historical review	1	8
Definition of concepts	1	10
Classification of concepts	2	9
Quiz game	3	8
Case study	2	10

Once we have evaluated all the available methods, we are in a position to select the appropriate subset to find a balance between QI and CA. To this end, we rely on multiple criteria decision-making techniques and on the concept of distance to an ideal point.

2.2 Finding a balance between quantitative intensity and concept amplitude

When two or more objectives such as QI and CA are in conflict, there is a need to find a balance between the achievement of alternatives measured in terms of these objectives. There is a need to find a compromise solution. Multiple criteria decision-making is a sound approach that may help teachers in the selection of best teaching methods. This approach allows teachers to include subjective preferences expressed in terms of weights attached to any of the objectives under consideration. However, once these preferences are expressed, our approach follows a rigorous procedure based on a logical sequence of steps that support teachers in dealing with complex decision-making contexts.

Our methodology is based on the concept of ideal point and the Zeleny's axiom of choice. Both concepts are key elements in the multiple criteria decision-making technique known as compromise programming [8]. The ideal point in a multidimensional space of criteria is the point where all criteria are simultaneously optimised. This point is usually infeasible because of the conflict between criteria that results in a decrease in one criterion when an increase in another criteria is observed. However, this point plays an important role as a reference point because the Zeleny's axiom of choice states that alternatives that are closer to the ideal point are preferred to those that are further [11].

As a result, our multiple criteria decision-making approach to select the best subset of alternative teaching methods is based on the following steps:

1 Establish a set of alternative teaching methods. Here, methods should be considered as a broad concept ranging from general methodologies such as gamification to more specific activities such as a particular quiz game.

2 Evaluate the set of alternatives in terms of two or more criteria which are of interest to the teacher. In the case of group of teachers, an auxiliary voting technique to find a consensus in the evaluation phase should also be chosen.

3 Express the preferences for the set of criteria in terms of weights attached to each of them. For consistency, a requirement in this step is that the set of weights adds up to one. For example, if CA is considered twice more important than QI, the weight attached to CA must be 0.67 and the weight attached to QI must be 0.33. Interactive techniques are available to facilitate the process of expressing preferences [8, 10].

4 Apply a distance function to evaluate alternatives in terms of the proximity to the ideal point. There are many different distance functions. The most widely used distance function in the context of multiple criteria decision-making is the parametric Minkowski distance function. By varying parameter "*h*" in the following Minkowski distance function, a family of particular distances with interesting features can be designed based on the implicit principles that parameter "*h*" imposes. As we will see in the Results section, parameter "*h*" adds meaning to the distance function selected.

$$\left(|x_1 - x_2|^h + |y_1 - y_2|^h\right)^{1/h} \quad (1)$$

5 Select a subset of alternative teaching methods as a compromise solution. This selection process may include not only the ranking of available alternatives but also a dominance analysis and set of possible constraints. By dominance analysis, we mean that some alternatives may be dominated by others in the sense that they are at most as good as others in one criterion (e.g., QI) but strictly worst in the rest of criteria (CA, in a bicriteria space).

3 RESULTS

In this section, we illustrate our proposed methodology with a numerical example derived from data shown in Table 1. Each subsection corresponds to one of the steps described in section 2.

3.1 Selection of teaching methods

The first step requires the consideration of a set of alternative teaching methods. A large set of teaching methods may enrich the analysis but it also may introduce unnecessary evaluation work if we know in advance that only a small group of teaching methods will be able to be deployed in practice due to time restrictions. As mentioned above, methods should be considered as a broad concept ranging from general methodologies such as gamification to more specific activities such as a particular quiz game. Table 1 summarizes the set of teaching methods considered in the context of teaching operations management in an MBA course.

3.2 Multicriteria evaluation

Once the set of alternative teaching methods is selected, the analyst must choose the criteria (objectives) that are going to be used for evaluation purposes. These criteria may be expressed in terms of objectives to fulfil or indicators to be maximized or minimized. When both objectives to maximize and to minimize are simultaneously considered, a transformation to align the achievement of all objectives is recommended. For example, if you want to minimize individual work, you can equivalently consider the maximization of collaboration. In the example shown Table 1, we consider the objectives of quantitative intensity (QI) and concept amplitude (CA) because we aim to find a balance between attributes appealing to engineers and attributes appealing to lawyers in in the context of teaching operations management in an MBA course. This evaluation is restricted to the scale 0-10. If there are objectives measures in different scales, a normalization process is required to transform measurements into a common scale. Finally, note that if more than two objectives are considered, the methodology described in this paper is still valid since the computation of distances can be extended to any number of dimensions.

3.3 Preferences

Preferences for QI or CA (or other criteria under consideration) may reflect either the particular desire of the teacher or the number of engineers and lawyers in the group. These preferences are usually expressed in terms of weights attached to objectives with the only requirement of consistency, for example, that the set of weights adds up to one. For simplicity, we consider a neutral teacher without particular preferences for either QI or CA. This case is equivalent to set the same weights to both QI and CA.

3.4 Distance to the ideal point

Our analysis of alternatives is based on the concept of ideal point in which both QI and CA are simultaneously maximized. Since this point is usually infeasible, there is a need to find a balance between QI and CA. To this end, we use the distance to the ideal point as a surrogate for utility derived from the combined achievement of QI and CA. As a result, our analysis is performed in a multidimensional space. In our case, we restrict the analysis to two dimensions (QI and CA) as shown in Figure 1.

Each point in Figure 1 is the location of a teaching method in the bidimensional QI-CA space derived from the evaluation in Table 1. The closer the method to the ideal point, the better the method in terms of QI and CA. Then, the ideal point acts as a reference point to compute distances that allows teachers to rank alternatives methods. The use of one distance function or another implies the integration of some decision-making principles that adds meaning to the final selection. In this paper, we consider three different distance functions:

1 The Manhattan distance, obtained when $h = 1$ in equation (1), is the sum of the horizontal and vertical deviations with respect to the ideal point (10,10).

2 The Euclidean distance, obtained when $h = 2$ in equation (1), is the square root of the sum of the squared horizontal and vertical deviations with respect to the ideal point.

3 The Chebyshev distance, obtained when $h = \infty$ in equation (1), is the maximum of the horizontal and vertical deviations with respect to the ideal point.

3.5 Final selection

The final step of our propose methodology is the selection a subset of alternative teaching methods as a compromise solution. From the analysis of Figure 1, we can exclude some alternative due to the dominance in the combined QI-CA performance. For example, the historical review is dominated by the case study and the quiz game because they are at most as good as others in CA but strictly worst in QI. As a result, no rational decision-maker would select the historical review instead of the case study or the quiz game because of the combined QI-CA performance.

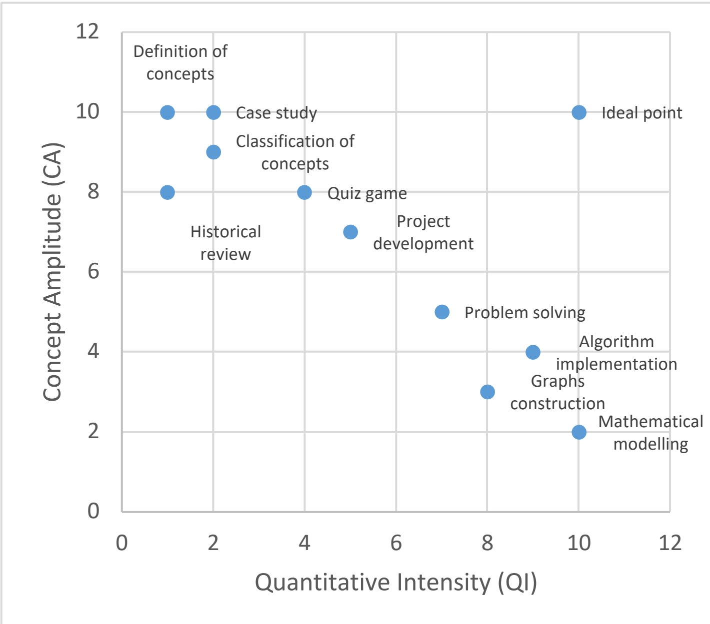

Figure 1. The quantitative intensity (QI) – concept amplitude (CA) space.

In addition, by considering the distance to the ideal point in ascending order, we can derive a ranking of alternatives. This ordering may help teachers to select a subset of teaching methods from this ranking according to the constraints in effort to prepare the required materials or in the diversity of methods.

Table 2. Distances to the ideal point for alternative teaching methods.

Teaching method	*Manhattan*	*Euclidean*	*Chebyshev*
Mathematical modelling	8,0	8,0	8,0
Problem solving	8,0	5,4	5,0
Graphs construction	9,0	7,3	7,0
Algorithm implementation	7,0	6,1	6,0
Project development	8,0	5,8	5,0
Historical review	11,0	9,2	9,0
Definition of concepts	9,0	9,0	9,0
Classification of concepts	9,0	8,1	8,0
Quiz game	8,0	6,3	6,0
Case study	8,0	8,0	8,0

Finally, the choice of one of the distance functions proposed in Table 2 implies the integration of a different principle in decision-making. By choosing the Manhattan distance, we are using the principle of maximum efficiency in which we focus only in the sum of total performance without considering the balance of solutions. Then, a combined performance (10,2) in mathematical modelling is as good as the (7,5) in project development because the distance to the ideal in terms of the Manhattan distance is the same (8). However, some teachers may be interested in avoiding corner solutions as the mathematical modelling, specially in teaching operations management to lawyers. To this end, the Euclidean distance represent a better way to integrate the principle of balance of solutions (expressed in the sum of squared deviations). In the limit, the Chebyshev distance integrates the Rawlsian principle of maximum fairness [13] because we aim to minimize the maximum deviation among the dimensions considered. We are indeed applying the minimax principle that considers only the performance of the worst-off objective.

4 CONCLUSIONS

Ineffective and inefficient teaching methods may lead to bad performance when students with different backgrounds are expected to learn the same contents. This paper deals with the challenge of teaching math and science (e.g., operation management) to an heterogenous group of students. Alternative teaching methods may be considered as to learn subjects with a high content of quantitative techniques. In this context, we recommend the use of multiple criteria decision-making techniques to select a subset of teaching methods that are evaluated in terms of two conflicting criteria such as quantitative intensity and concept amplitude. The first criterion may be motivating for engineers and frustrating for lawyers, and the second one works in the opposite direction. In order to find a balance between two or more objectives when teaching to a heterogeneous group, we propose a methodology to support the selection of teaching methods. The results derived from this methodology enable professors to consider their particular preferences and to integrate important decision-making principles by selecting the appropriate distance function to an ideal point that acts as a reference.

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