INFORMS Transactions on Education

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

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Vol. 12, No. 3, May 2012, pp. 140–146
ISSN 1532-0545 (online)
INFORMS Transactions on Education
informs
http://dx.doi.org/10.1287/ited.1120.0086

Teaching Note

Learning Outcome Assessment Using an Integrative Assignment on Location Decision Making

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Driven by the need to develop an integrative tool to assess learning outcomes for an Association to Advance Collegiate Schools of Business (AACSB) accredited MBA program, this teaching note presents a unique assignment that requires students to identify appropriate decision modeling tools for the multi-step analysis to support a location decision. The specific value of this assignment is that although the business scenario is simple but nevertheless realistic, developing the supporting analysis requires application and integration of several decision making models. Students need to exhibit the capability to choose appropriate models, to apply them correctly, and to link the results together to support the final, integrative decision. The assignment therefore allows instructors to evaluate two aspects: (1) proficiency with individual modeling tools and (2) the ability to combine such tools for a comprehensive analysis of a realistic business scenario. The assignment is applicable to learning outcomes assessment for learning objectives such as technological and quantitative skills or critical thinking.

Key words: assessment; spreadsheet modeling; evaluating students; accreditation
History: Received: May 2011; accepted: January 2012.

1. Introduction

Accreditation processes, for example by organizations such as the Association to Advance Collegiate Schools of Business (AACSB), aim at improving quality in higher education. "Assurance of Learning Standards evaluate how well the school accomplishes the educational aims at the core of its activities" (AACSB International 2011, p. 59). Following the AACSB standards, institutions define mission-based learning goals. These are evaluated, for example, through course-embedded assessment (Spruell et al. 2009), often by employing rubrics, which are considered to be efficient tools to assess whether students reach expected performance levels (Martell 2007). A rubric is generally a matrix of descriptions of a learning goal: a specific assignment task along one dimension, a performance level scale on the other dimension, and definitions of expectations for each performance level (Stevens and Levi 2005, Shaftel and Shaftel 2007, Spruell et al. 2009). Table 1 exemplifies a rubric for course-embedded assessment of the learning goal "technological skills" (the faculty at my institution agreed to use the term "technological skills" to assess students' abilities in using technological tools, such as specific software packages such as Excel, Access, data mining programs). The first column defines the traits that constitute the learning goal. The criteria for each of the three performance levels ("Does not meet expectations," "Meets expectations," and "Exceeds expectations") are given in the respective rows.

After the formulation of the rubric, selection of suitable assessment methods follows. As Johnson et al. (1993, p. 153) point out, "There is no more critical juncture in implementing a successful assessment [...] than the moment of the methods selection."

At my institution, we experienced that although learning goals, traits, and performance levels are clearly defined, there is a lack of assignments that adequately address the expectations for each performance level. Consequently, faculty needed to develop appropriate assessment tools. I expect that faculty at other institutions may experience similar challenges. To address these, this article provides an integrative spreadsheet modeling assignment for the assessment of technological or quantitative skills in decision sciences courses at the master degree level. The assignment is integrative because it asks students to analyze a location decision for a service organization (ice cream parlor) using different modeling methods, with the results of one model providing the input data for the next. Students are confronted with an almost real-world situation, having to prepare a critical business decision armed with data and their knowledge of decision modeling. The assignment does not specify which models to employ; thus, students are challenged to select adequate models that in the aggregate support final decision making. It is this simulation of a realistic business scenario that tests not only the understanding of but also the ability to apply and critically evaluate the decision-making models. Thus, the assignment put forth provides instructors with a distinctive tool for assessment of not only learning goals but also student performance in general.

2. The Assessment Rubric

Table 1 represents the rubric of the learning goal "Technological Skills" for the AACSB accredited MBA program at Marist College, together with an example of assessment results, which are discussed in a later section.

The decision sciences course (a mandatory core course) was chosen for course-embedded assessment of this learning goal. Rephrasing the traits as provided in Table 1, the following skills are assessed:

Understanding a business scenario and applying various, adequate decision-making models

Integrating results of different models

Interpreting and critically reviewing all model outcomes

Using results to make a sound business decision

The particular challenge for the formulation of an appropriate assessment tool lies in the requirement that multiple decision-making models (technological tools) are applied and that their results are integrated to formulate the final business decision. Assignments provided through textbook support material or case studies generally ask for the application of just one specific model to allow students to practice the learned material in a focused manner. Hence, I needed to develop a multistep business decision scenario, which requires students to use various decision models and to finalize the decision based on the outcome of all models. Each individual decision model is purposefully only moderately complex because the focus of this assignment is not on advanced modeling. Rather, students need to decide themselves which model is appropriate to address a question, and then they need to combine modeling outputs to support their final decision.

3. The Assignment: A Multistep Location Decision

I chose the topic "location decision" because its underlying principles are intuitive even if students have not been exposed to this topic in depth.

Choosing a good location requires identifying key success factors for a given business and then comparing available locations with regards to these factors. Manufacturing location decisions are generally driven by cost or supply chain factors (producing a product efficiently, minimizing supply chain and transportation costs), whereas service organizations need to focus on market and revenue (accessibility for the customer) because the customer is usually present to receive the service.

Table 1 **Assessment Rubric for the Learning Goal "Technological Skills" with an Example of Assessment Results** ($n = 17$)

Trait	Does not meet expectations 1	Meets expectations 2	Exceeds expectations 3
Apply multiple technological tools to analyze and formulate solutions to business problems	Applies at most one technological tool to analyze and formulate solutions to business problems 1 or 5.9%	Applies two technological tools to analyze and formulate solutions to business problems 2 or 11.8%	Applies more than two technological tools to analyze and formulate solutions to business problems 14 or 82.4%
Analyze business problems from different perspectives using technological tools	Analyzes business problem from only one perspective using technological tools 2 or 11.8%	Analyzes business problem from two perspectives using technological tools 7 or 41.2%	Analyzes business problem from more than two perspectives using technological tools 8 or 47.1%
Evaluate multiple contingencies into analysis and solution formulation using technological tools	Evaluates one or fewer contingencies in analysis and solution formulation using technological tools 2 or 11.8%	Evaluates two contingencies in analysis and solution formulation using technological tools 3 or 17.6%	Evaluates more than two contingencies in analysis and solution formulation using technological tools 12 or 70.6%
Incorporate multiple contingencies into analysis and solution formulation using technological tools	Incorporates one or fewer contingencies in analysis and solution formulation using technological tools 3 or 17.6%	Incorporates two contingencies in analysis and solution formulation using technological tools 7 or 41.2%	Incorporates more than two contingencies in analysis and solution formulation using technological tools 7 or 41.2%

Table 2 Historic Data from Franchisor

Parlor location (county)	Revenue ($)	Traffic counts (cars/hour)	Residential population around location	Advertising budget ($)
Bradford	950,000	115	66,000	6,500
Clay	870,000	92	54,000	5,500
Dixie	1,020,000	145	110,000	8,000
Glades	680,000	54	45,000	7,200
Jackson	990,000	99	105,000	5,500
Miami-Dade	1,200,000	183	130,000	6,700
Palm Beach	1,120,000	156	110,000	7,000
Sarasota	975,000	120	72,000	5,500
Wakulla	650,000	50	48,000	4,000

Note. Data are averaged over a 10-year period.

The assignment asks the student to find the optimal location for a franchised ice cream parlor. The type of business is purposefully chosen to be uncomplicated, so students do not need detailed industry knowledge to understand the success factors. Because an ice cream parlour is a service organization, a key driver for its location decision should be revenue, which in turn is driven by the number of customers that visit and purchase ice cream or other products. Three potential locations are given together with supporting (hypothetical) data (see Tables 2 and 3). The actual assignment material, as given to the students, is provided in the appendix. The students receive the supporting data and a description of the scenario but not information on which models to use nor any model templates.

Figure 1 (not handed to students) provides a schematic of the flow of the assignment, and the following describes the four steps required to solve it.

(1) Regression: The driving success factor for the location decision is revenue. Hypothetical historic data from other existing parlors the franchisor owns are provided, showing revenue, traffic count, population, and marketing budget. In the first step, students need to determine which of these three factors influences revenue the most. This requires running simple and multiple regressions. The initial data are designed in such a way that the simple regression for traffic count versus revenue has the highest coefficient of determination (R^2) value, followed by population versus revenue. Other statistical metrics commonly used when assessing regression outcomes, such as the correlation coefficient or standard error of the regression estimate, also provide evidence that the relationship between traffic count and revenue is the strongest. The marketing budget, on the other hand, has a very low R^2 value. Multiple regressions with two or three variables can also be considered. Based on adjusted R^2 values, the combination of traffic and population is the regression model with the highest explanatory power.

Table 3 Information Regarding Locations *A*, *B*, and *C*

Location	Details	Residential population	Advertising budget ($)
A	Next to main shopping mall	51,000	6,000
B	At intersection next to train station	55,000	5,500
C	Outskirts of town on road to National Park, local attraction	43,000	7,500

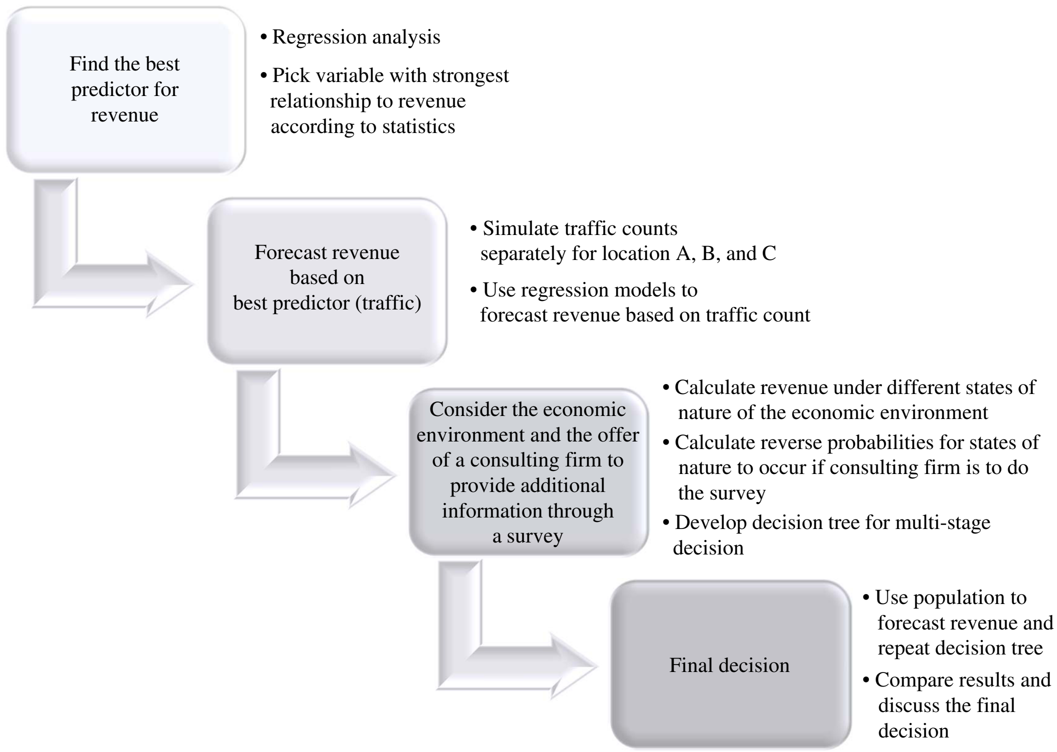
(2) Simulation and forecast of revenue: For the three potential locations, information regarding traffic patterns is given. In order to forecast revenue, given its dependence on traffic count, traffic simulation models need to be developed to generate these counts. Each location has a different traffic scenario that requires building simulation models of varying complexity. For Location *A* (see Table 4), a frequency table of different traffic counts is provided. Traffic at Location *B* (see Table 5) follows a normal distribution but differs for weekdays and weekends. Lastly, traffic at Location *C* is influenced by the weather (i.e., temperature), with two different traffic count frequencies given for below or above 90 degrees Fahrenheit. In this case, students need to simulate daily temperature (average number of days per year above 93 degrees is given) and integrate the simulation outcome into the traffic simulation (see Table 6).

The three different traffic patterns lend themselves to a discussion on the theory of probability distributions, adding further depth to student learning.

The assignment is designed for using Excel's basic simulation and data table function; however, instructors can easily modify this part in case other simulation software is used in a given course. Based on the simulation outcome and the regression models from step 1, students can forecast revenue and compare with a forecast based on population or a multiple regression model.

(3) Decision making: Information (also hypothetical) is provided on the current economic environment (states of nature), and on the costs of a study from a consulting company that could provide more accurate probabilities that the different states of the economy (recession, stable, boom) will happen. At this point students need to use the forecasted revenue, apply the impact of the states of nature, and develop a multistage decision tree to determine if the study should be performed and which location to choose. This requires using Bayes Theorem to calculate reversed probabilities for the performance of the consulting firm (input data given in Table 7). If Bayes Theorem is not explicitly covered in a given class, it is possible to remove the option of the economic study, and hence the need to calculate revised probabilities, from the assignment.

Figure 1 Schematic of Assignment Flow



(4) Interpretation: The students should have obtained revenue forecasts for each of the three locations, based on traffic counts and, although this represents the weaker correlation, based on population or the multiple regression using both traffic count and population (the assignment asks to use the two best predictors for revenue). Based on the regression results alone, students can make a preliminary decision regarding the optimal location, which turns out to be location *A* (when using traffic count). They also have the outcome of the decision tree that furthermore integrates the possibility of conducting a marketing study *and* considers the economic environment. They can now discuss whether the preliminary location choice still remains appropriate and why. The initial data are designed so that the offer of the consulting firm should be rejected, and the optimal location is *C* (again, when using traffic count to forecast revenue). Discussions should follow. First, the students should take note that the decision based on the regression alone leads to a different location than when also solving the decision tree. The lesson learned is that if possible, multiple decision criteria should be analyzed before drawing a final conclusion. Second, the correlation of traffic count and revenue is only marginally stronger than population. A prudent decision maker would consider if and what kind of changes may occur in these two variables in the foreseeable future (e.g., road or housing development construction) and what impact this may have on the chosen location. Lastly, the results of the decision tree are very close for the two alternatives of accepting or rejecting the offer from the consulting firm. Students should discuss the robustness of the model and steps they might take to further support the final decision.

Table 4 Frequency of Different Traffic Counts for Location *A*

Location *A*—Probability of traffic counts	
Number of cars	Frequency
60	10
70	30
80	60
90	110
100	75
110	20

Table 5 Probability Distribution for Traffic for Location *B*

	Location *B*	
	Mean	Standard deviation
Weekday	70	2
Weekend	45	5

Notes. Traffic patterns at the train station (Location *B*) follow a normal distribution: during weekdays, the mean is 70 with a standard deviation of 2; on weekends, the mean is 45 with a standard deviation of 5.

Table 6 Frequency of Different Traffic Counts for Location *C* for Two Temperature Ranges

Location *C*	
Cars/hour	Frequency
Traffic pattern on days below 90° F	
60	32
70	55
80	67
90	77
100	70
110	60
120	45
Traffic pattern on days above 90° F	
20	20
30	42
40	55
50	67
60	45
70	25
80	5

Note. Average number of days per year above 90° Fahrenheit: 93.

Given the considerable time it takes to build the consecutive models, this assignment should be used as a take-home exam or as a series of assignments throughout a course. Using it throughout the semester opens the opportunity for class discussion on the characteristics of each step, why a certain model is appropriate to solve it, the robustness of the model, etc.

4. Conclusions

This teaching note discusses an integrative, multi-model decision-making assignment for assessment purposes of the technology skill program objective of an AACSB-accredited MBA program. The assignment consists of a multistep location decision that requires students to use regression analysis, simulation models, and forecasting based on a regression model as well as a multistage decision tree that requires the calculation of reverse probabilities. The students are provided with only a data set and several questions and have to independently determine which models are adequate. I have given this assignment as a final exam (take-home) in two recent decision-making courses (total of 82 students). Based on assessment procedures at my institution, 17 randomly selected exam submissions were then used to assess the program objective "technological skills" as shown in Table 1. This assessment rubric requires students to apply multiple decision-making tools and to analyze and interpret all outcomes in an integrative manner, clearly showing if they understand the purpose of a decision model and how to connect the different results.

Table 7 Past Performance of the Consulting Firm

When the economic environment was	Study result was	
	Positive	Negative
Economic boom	0.87	0.13
Stable economy	0.54	0.46
Recession	0.13	0.87

Notes. Read the table as follows: The probability of positive survey results, given an economic boom, is 0.87. (P(Positive Study | Economic Boom) = 0.87).

Table 1 includes the outcome of the assessment. It is outside of the scope of this teaching note to discuss the conclusions of the instructors of the MBA program. Rather, Table 1 attempts to exemplify that the proposed assignment helped the assessor to accomplish the assessment. The first trait entails that multiple technological tools are used to analyze business problems. Textbook problems are in general chapter specific and thus focus on only one model or tool at the time. This assignment, however, enables the assessor to evaluate whether a student appropriately chose different and appropriate modeling tools to address the business decision at hand (i.e., was able to determine that the first step requires a regression and then sequentially used the regression results to solve the other required models).

The assessment for the first trait was accomplished by evaluating how many modeling tools a student used appropriately and correctly and hence receiving a score according to the performance level of the trait. For example, a student who correctly built the regression and simulation models but failed to solve the last part using a decision tree would score the level "meets expectations."

The second trait was assessed by determining how well students integrated the results of the individual steps (i.e., models used) into an inclusive decision. For example, a student who solved the traffic simulations but failed to understand that this is the input to calculate a revenue forecast, which in turn is a required data point for the decision tree, is assessed a performance level of "does not meet expectations."

The remaining two traits address whether students can adequately compare the results of the entire assignment when using traffic or when using population as the variable to build the sequential models. The assignment asks students at the end to discuss their results. For example, a student who indeed modeled and discussed the assignment using two variables (traffic and population) scores a performance level of "meets expectations." A score of "exceeds expectations" is achieved when a student considered two simple and a multiple regression.

Program objectives vary between institutions and so will the rubrics, traits, and performance levels educators articulate. Nevertheless, I believe that this decision-making assignment is applicable to various assessment situations. Although it is modeled after a fairly simple but realistic business scenario, solving it correctly and proficiently requires several steps and a solid understanding of how to integrate the results of different models. As such, it is testing students' critical and integrative thinking capabilities, which are very likely to be found in program objectives. Instructors can also divide the assignment into multiple parts if the design of the course does not allow for a lengthy final exam. The input data and details of the scenario can easily be manipulated to create different assignment versions that allow instructors to design other follow-on discussions regarding decision modeling itself, business decisions in general, or the various aspects of location decisions.

Admittedly there is no option to vary the type and sequence of models used. This can become an issue when students have to repeat the course or communicate in detail with peers that took it in the past. As with any other assignment given repeatedly, the only remedy is to develop a portfolio of versions that vary significantly enough to confound students that have information they are not supposed to have.

Questions may also arise on the reliability of an assessment method. According to Cherry and Meyer (1993), there are three sources of measurement error: the individuals responding to the assignment, the administration and scoring of the assignment, and the assignment itself. Erwin (1991) recommends coefficients of at least 0.70 for interrater reliability when rating scales are used. Palomba and Banta (1999) endorse that careful training of evaluators and the development of very clear and coherent rubrics significantly improve interrater reliability. It is the topic of further research to evaluate interrater reliability when using the presented assignment.

Also a subject of future work is the refinement of this assignment by gathering student self-assessment data. Instead of using fictive data, the assignment could also gain in relevance by obtaining real-world information from franchising organizations.

I will gladly provide the solution to the assignment upon request.

Appendix. The Assignment Material Provided to the Students

Location Decision Final Exam

Finding the optimal location for a firm is a long-term strategic decision with important consequences for the success of that firm. You will use quantitative decision-making models to find the optimal location for an ice cream parlor. As is generally the case for service organizations (such as a food related business), the optimal location is largely driven by the need to optimize revenue: because customers are generally present when services are provided, the business needs to optimize the number of people that can get to it. This in turn can be dependent on, e.g., potential market size (population in general, target population); ease of access to the facility (roadways, chances of drive-by customers, parking); neighborhood (attractions, shopping, related services, safety etc.); or publicity (marketing).

The ice cream parlor is a franchise, and the franchisor is providing initial data regarding criteria that potentially impact revenue: traffic count (a proxy for both access and neighborhood), population, and marketing budget (Table 2). You have identified three locations (close to the mall (*A*), next to the train station (*B*), or on the way to a National Park (*C*)) that you are evaluating. Information on traffic patterns, estimated marketing budget you can afford, and population around these three locations is provided (Table 3). Assume that you are living in an area that does not encounter major effects of seasonality (i.e., demand for ice cream is stable throughout the year). Furthermore assume that costs (such as a lease) for the three different locations do not differ greatly, so the decision is indeed driven mainly by revenue.

You also collected the following information: the data from the franchisor are based on the past 10 years, which has seen a relatively stable economy. You are, however, expecting the economy first to contract before booming again. You estimate that the impact on revenue of such economic fluctuations is strongest for the location close to the mall (*A*), medium in vicinity of the train station (*B*), and least for the one being close to the National Park (*C*). You expect revenue to shrink for location *A* by 25% during a recession but increase by 10% if the economy picks up. For location *B*, you expect a decrease of 15% for a recession and an increase of 10% for an economic boom. Lastly, for location *C* you are expecting an increase of 5% for a boom and a decrease of 5% for a recession. You estimate probabilities to be 0.6 for a recession, 0.3 for the continuation of a stable economy, and 0.1 for an upswing. However, you also got an offer from a local consulting firm to study the economic prospects. The study would cost $15,000. The firm provides you with probability data to judge the accuracy of its performance (Table 7).

The following tables provide all needed data (please note that all data are hypothetical):

- Table 2: Historic data from franchisor
- Table 3: Information regarding locations *A*–*C*
- Table 4: Probability distribution for traffic at location *A*
- Table 5: Probability distribution for traffic at location *B*
- Table 6: Probability distribution for traffic at location *C*
- Table 7: Past results and probabilities of the consulting firm

The following steps will guide you through this location decision scenario:

(1) Which variables have the strongest relationship with revenue: traffic count, residential population, marketing budget, or any combination of them?

(2) Forecast revenue for location *A*, *B*, and *C*. This step may require you to first develop models that generate appropriate forecasting input data. Make a preliminary decision: given the information you have thus far, which would be the optimal location? You should make at least two different forecasts, picking the best variables (or combinations thereof) based on the results of part 1.

(3) You now have revenue forecasts for each location. Develop a decision model that considers the effect of the state of the economy on the three locations. Include in your model whether the economic survey offered by the consulting company is worth performing. Consider the data the consulting company provides regarding the probability of its performance.

(4) Discuss your findings in detail. Compare the strengths of the models you used and make your final recommendation.

Hints:

— If you run simulations, assume four weeks (28 days) of activity and then use the DataTable function with $N = 300$.

— You will open a parlor in one of the locations; in other words, there is no option of "do nothing."

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