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A Decision Support System Example

George Schell
University of North Carolina Wilmington, SCHELLG@UNCW.EDU

A DECISION SUPPORT SYSTEM EXAMPLE: A BETTER WAY TO TEACH PROBLEM-SOLVING AND DATABASES

George Schell
University of North Carolina Wilmington
schellg@uncw.edu

ABSTRACT

Teaching the role and value of information systems (IS) in the decision process is an important goal of the introductory IS course. Experiential learning encourages students to become engaged in the learning process and become more invested in the learning experience. A way to achieve this is to use an example of a decision process and then explain where information is used to support the decision process. Critical thinking and the role of data to support quantitative critical thinking come from concrete examples that students understand.

It is a mistake to teach the introductory IS course as a series of techniques and applications without basing them in the context of a practical example. Yet that is often the case. The introductory class is for all business students. Using the class as a means to recruit information systems majors is fine. Failing to use the class to educate non-information systems majors of the importance of information systems in the achievement of organizational goals is a mistake.

Keywords

Information systems, curriculum, critical thinking

INTRODUCTION

The introductory information systems (IS) course in business schools is typically taken by all business majors. This means many, if not most, of the students enrolled in the course are not going to become information systems majors. It is a mistake to view the introductory IS course as simply a recruiting course for IS majors. All functions in an organization use information and so all students in the introductory course, and even non-business majors, should have an understanding of the role and value of information systems when they complete the course. The best way to demonstrate role and value is by providing examples that students can understand and then manipulate on their own.

Ignoring the importance of educating non-information systems majors about the value of information systems leads to a dismissive attitude towards the discipline. Bakerville and Myers (2002) argued that MIS is a discipline in its own right, no longer in need of justifying itself via a reference discipline. Benbasat and Zmud (2003) followed by admonishing/prodding information researchers into investigating those things "intimately associated with" information systems. If we as academics in the IS discipline want our students, colleagues, administrators, and industry to understand the importance of the discipline then we must show both information systems majors and non-majors the role our discipline plays in organizations.

We treat our students to shiny new fads and just-released technology. It is no wonder that so many non-information systems majors leave the introductory class with the impression that our discipline is akin to the newest iPhone – just something shiny to use and a better one will come along in a year.

The basis for constructivist learning is to have students learn and discover how to apply concepts and tools to the example provided. They are actively engaged in learning how to learn. This constructivist approach is not new (Jonassen, 1994) and has been argued as technology increasingly influenced business disciplines (Leidner and Jarvenpaa, 1995). Using the constructivist approach becomes essential because of the increasing power of the computer.

Moore's Law makes the teaching of information skills without the underlying concepts a particularly foolhardy endeavor. Tools constantly evolve to utilize the increased power of computers. Look at the cover of the January 2017 *Communications of the ACM* and read the tombstone epitaph for Moore's Law. It channels Mark Twain's quip that "reports of my death are greatly exaggerated." The article and charts by Denning and Lewis (2017) makes it clear that in the 50 plus years since Moore's Law prediction it has held true.

The implication is that problem-solving methods are intertwined with the power of information technology. To follow the flow in its natural progression the instructor should begin with the decision to be made, next express the decision as a quantifiable problem, and then demonstrate how information is used to support the problem solution. For this to be achieved it becomes paramount to teach the role of information technology (concepts and theories) and teach the use of technology tools as supportive to the concepts and theories.

Teaching students to use query statements and expecting that lesson to enlighten them about the importance of information systems in modern organizations is like teaching students about knives and expecting them to infer the importance of surgery. (Apologies to Edsger Dijkstra.) I am a proponent of constructivist learning and that leads me to design an instruction method that leads students to solve problems. I.e., do not lay out the steps of a solution and then require students to use tools for those steps. Instead, clearly state what outcome should be accomplished, teach students tools that can attain that outcome, and let students choose how to construct a solution.

Students need a solid understanding of the logical steps to make a decision (i.e. to solve a problem) as well as how to use quantifiable data in the decision. Without that understanding the teaching of skills such as creating a query will result in a disjointed view of the role of information systems as separate from problem solving. Managers and professional staff are problem solvers and problem solvers use quantifiable problem solving methodologies, and those methodologies require data (Martin, Klein and Sullivan).

It would be a mistake to teach a problem solving method concept followed by a separate, independent information systems concept (such as databases). The two concepts naturally complement each other in the problem solving process and students will benefit from the application of the database concept to the decision solving application that has been used. Requiring students to solve assignments and work through problems fosters a deeper understanding of the course materials (Schell and Janicki, 2013).

The remainder of this paper presents an example that provides an analytical approach to problem solving followed by a series of follow-up concepts to be explored concerning databases. This approach will intensify the student learning experience (Frownfelter-Lohrke, 1998). The full and explicit explanation of the problem solving method is critical before IS techniques are introduced.

CONSTRUCTING THE EXERCISE PROBELM

An exercise problem should reflect the learning objectives of the course. Avoid a goal of "creating a query to total field values in a table." That is a skill. Avoid a goal such as "demonstrating the difference between relative and absolute cell addresses in a spreadsheet." That is a skill. Choose a goal that focuses on the learning objectives for the introductory information systems course.

I choose to create an exercise that (1) illustrates the necessity of information to support quantitative, critical thinking and (2) demonstrates the concept that data needs to be processed into information. Textbooks frequently contain exercises but those exercises tend to verify that material in a particular section of the text has been understood. Instructors should lead students through the exercise and pay special attention to focus attention on learning goals.

Students are introduced to a problem explained in general terms: your company makes several products, each has an individual profitability, and the products are comprised of materials (and possibly labor). There is a limit to the demand for each product and a limit to each material. How do you combine materials to make profits without violating limitations on supply or demand?

That discussion with students should lead to their 'discovery' that maximizing the profits requires a quantitative analysis with data. The analysis can be performed using a spreadsheet as a tool, particularly the problem solver function within the spreadsheet tool. When students understand how to quantitatively define the problem in mathematical terms they achieve the first learning objective – quantitative, critical thinking.

After having students solve the maximum profitability problem using various assumptions about prices, costs, profits, supply, and demand the instructor moves to the question of how to gather actual facts (not guesses) required to generate a problem answer. That leads to discussions of a database which contains data that must be processed before it is usable in the spreadsheet model. Thus begins the achievement of the second learning goal.

A CONCRETE EXAMPLE

The students are to assume that they work for an organization that creates a time sensitive product. One example might be a grocery store that sells an item that has a 'sell by' date that makes the item perishable. To make the example more specific but simple, assume the grocery store sells chickens and that chickens unsold by the 'sell by' date can be cooked and sold in the store on the date the chicken is cooked. Fresh chickens, i.e. those that have not reached the 'sell by' date, can also be cooked but they have a lower profit margin. Chickens that have reached their 'sell by' date are either cooked and sold or they must be disposed to a company manufacturing pet food. Chicken that has reached its 'sell by' date but is not cooked will also be disposed to the company manufacturing pet food.

There are two raw materials in this exercise; fresh chicken and 'sell by' chicken (chicken that has reached its 'sell by' date). The 'sell by' date is a specific day so past that date the grocery store will not use the chicken as a raw material. While it may intuitively seem that only two products exist, there are actually three products. First, a packaged chicken which is just the fresh chicken itself (profit of $2.00 per chicken). Second, a cooked chicken that is created using a 'sell by' chicken as the raw material (profit of $1.25). Third, a cooked chicken that is created using a fresh chicken as the raw material (profit of $0.60).

There are limits to the amounts of raw materials that are available. The students can assume that for the current problem the available number of fresh chickens today is 500. And that the number of 'sell by' chickens is 100. However, just because the grocery store has chickens to sell does not mean customer demand will sell all available chickens. Assume that today's demand for fresh chickens is 300 and the demand for cooked chickens is 125. For this example, we will assume that 125 total is broken up with 75 cooked chickens made with 'sell by' raw material chickens and 50 cooked chickens made with fresh chickens.

The raw materials available, the demand, and even the profit per sale of a products are all determined daily.

Refer to Figure 1 to see how this problem description can be expressed within an Excel spreadsheet. At this point the instructor should introduce the Excel spreadsheet and point out the location of the information above that will be pertinent to solving for a maximum profit. Note that the numerical values in the paragraphs above have been displayed in red so that it is easier for a student to quickly identify them.

This problem will be solved using the Solver add-in feature of Excel. By choosing the 'Data' tab in Excel you should see the 'Solver' option be displayed. If you do not see 'Solver' then you can choose the 'File' tab followed by the 'Options' choice followed by the 'Add-ins' choice and you can manage the add-ins to enable 'Solver.'

	A	B	C	D	E	F	G	H
1			**Raw Materials**					
2			Fresh Chicken	"Sell By" Chicken	# to Sell	Profit per Sale	Revenue per Product	
3		Packaged Chicken	1		0	**$2.00**	$0.00	
4	**Products**	Cooked Chicken (at 'sell by' date)		1	0	**$1.25**	$0.00	
5		Cooked Chicken (from 'fresh' chicken)	1		0	**$0.60**	$0.00	
6							$0.00	**Total Revenue**
7								
8			Limits on Raw Materials		Used			
9			Fresh Chicken <=	**500**	0			
10			"Sell By" Chicken <=	**100**	0			
11								
12			Demand					
13		Packaged Chicken	**300**					
14		Cooked Chicken (at 'sell by' date)	**75**					
15		Cooked Chicken (from 'fresh' chicken)	**50**					

Figure 1. Exercise Problem Expressed Within an Excel Spreadsheet

Explaining the Spreadsheet

The three product names are described in cells B3, B4, and B5. The raw material names are described in cells C2 and D2. The values for 'Limits on Raw Materials' and 'Demand' should be self-explanatory. However, the students should be walked-through explanations for many of the remaining cells because they are either calculated cells or they are cells used by the 'Solver' add-in.

Cells C3 to D5 contain values reflecting how much of a given resource is in a product. For the 'Packaged Chicken' product 1 unit of 'Fresh Chicken' raw material is used and 0 units of 'sell by' chicken. For the 'Cooked Chicken (at "sell by" Date)' product 0 units of 'Fresh Chicken' raw material is used and 1 unit of 'sell by' chicken. For the 'Cooked Chicken (from "fresh" chicken)' product 1 unit of 'Fresh Chicken' raw material is used.

A typical product would use different amounts of multiple raw materials but in this simplified example only one ingredient is used. For an introductory IS course that has additional focus on software solutions to problems the model could be expanded to include a column for 'Labor' and 'Cooking Equipment' and the respective cells would be populated with values.

Calculated Cell Values

Several cells in the spreadsheet are calculated based upon information already contained in the spreadsheet. The column of 'Revenue per Product' is based on the number of products of that type sold multiplied by the profit per sale. Cell G3 = E3 * F3. Cell G6 = G3 + G4 + G5, the total revenue of the three products being made.

The cell values under the ‘Used’ heading may be a little more difficult for students to grasp. But students should be able to conceptually understand that the total number of ‘Fresh Chicken’ raw material used for the ‘Packaged Chicken’ product equals the number of ‘Fresh Chicken’ in each ‘Packaged Chicken’ multiplied by the number units of ‘Packaged Chicken’ produced. That means the number of ‘Fresh Chicken’ used (cell E9) equals (C3 * E3) + (C4 * E4) + (C5 * E5). The number of ‘sell by’ chickens (cell E10) is similarly calculated.

Cells Used by Solver

Figure 2 contains the Solver information. The objective is to maximize the total revenue, i.e. the value in cell G6. This will be accomplished by changing the number of each product to be sold (see the ‘# to Sell’ heading in Figure 1, cells E3, E4, and E5). If the example had no constraints the solution would be to simply keep making packaged chicken and cooked chicken. However, the example cannot produce more products than available raw materials allow and cannot product more product than is demanded.

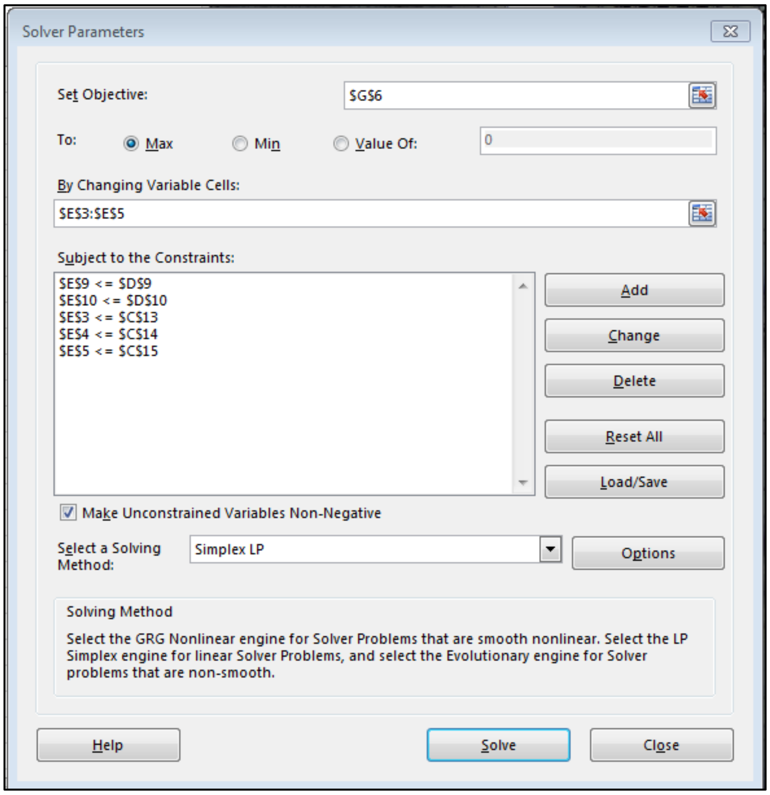

Figure 2. Solver Information

The first constraint, you cannot produce more products than raw materials will allow, is shown in the first two equations in the ‘Subject to the Constraints’ box in Figure 2. Remember than the value in cell E9 is the sum of all ‘fresh chicken’ raw material used across the production of the three products. E9 must be less than or equal to the limit of the fresh chicken raw material value in cell D9. The second constraint showing E10 is less than or equal to D10 follows the same logic for the ‘sell by’ chicken raw material.

The last three constraints limit the number of units of a product to be sold to be less than or equal to the demand for that product. Cell E3 contains the number of ‘Packaged Chicken’ products to be sold and it must be less than or equal to the demand for ‘Packaged Chicken’ shown in cell C13. Constraints on the last two products are created in a similar fashion. The problem is solved using the Simplex LP method.

Figure 3 shows the solution that maximizes the total revenue from the three products. Students must be shown more than just the total revenue produced, they need to understand how the constraints were implemented in the solution. For example, only 300 ‘Packaged Chicken’ products were used but 350 ‘Fresh Chicken’ raw materials were used. 300 fresh chickens were used for the ‘Packaged Chicken’ product and 50 units of fresh chicken were used in the ‘Cooked Chicken (from “fresh” chicken)’ product.

Although there were 100 ‘sell by’ chickens available only 75 were used. That means the remaining 25 ‘sell by’ chickens will be sent to be turned into pet food. There are 150 fresh chickens remaining (500 – 350) and it can be assumed that some will become ‘sell by’ chickens on the next day when the example would be solved again using updated data.

	A	B	C	D	E	F	G	H
1			Raw Materials					
2			Fresh Chicken	"Sell By" Chicken	# to Sell	Profit per Sale	Revenue per Product	
3		Packaged Chicken	1		300	$2.00	$600.00	
4	Products	Cooked Chicken (at 'sell by' date)		1	75	$1.25	$93.75	
5		Cooked Chicken (from 'fresh' chicken)	1		50	$0.60	$30.00	
6							$723.75	Total Revenue
7								
8			Limits on Raw Materials		Used			
9			Fresh Chicken <=	500	350			
10			"Sell By" Chicken <=	100	75			
11								
12			Demand					
13		Packaged Chicken	300					
14		Cooked Chicken (at 'sell by' date)	75					
15		Cooked Chicken (from 'fresh' chicken)	50					

Figure 3. Maximum Solution

THE TIE TO A DATABASE

The database concepts should be introduced only after the need for data and the origins of that data are understood by the students. For example, begin with the fact that the problem to be solved is a daily occurrence. The reason is that on any given day a ‘sell by’ date might be reached on one of the ‘fresh’ chickens. A second reason is that the cooked chickens can only be sold on the date they are cooked. Cooked chickens that are not sold plus the ‘sell by’ chicken raw material that is not used must be sent to the company that uses them in the production of pet food.

The key data for the example are the values in the spreadsheet that are shown in red. How are the demand values determined? Does a store manager use his/her best judgement to estimate the next day’s demand? Is a sophisticated analytical model used that tracks daily sales, marketing campaigns, competitor pricing, social media, and other sources? What would students suggest?

How is the supply of the raw materials determined? A worker can go through the display case at the end of the day and determine how many fresh chickens have reached their ‘sell by’ date. That becomes the limiting number of ‘sell by’ chickens that can be used as a raw material. Cell D10 in the figures displays this value.

The number of fresh chickens that can used as raw material for products is more complicated. The worker could simply count how many fresh chickens are left in the case. Or the worker could subtract the number of chickens reaching the ‘sell by’ date from the number of chickens originally in the case. The number of fresh chickens scanned as they are sold at the check-out counter could be subtracted from the original number of fresh chickens, but you would still need a worker to determine which fresh chickens have reached their ‘sell by’ date.

Fresh chicken raw materials are also impacted by shipments received. The amount of fresh chickens arriving today would be added to the inventory of fresh chicken in the display case. These values are displayed in cell D9.

The determination of the profit per product is the most complicated of values in the example. Profit is simply the price of the product minus its cost. The price of a fresh chicken can change daily. The cost of every fresh chicken is unknown because the cost can vary by which vendor provided the fresh chicken, when the fresh chicken was purchased, and even other factors. Students would need to take the average cost of a fresh chicken and subtract that amount from the daily price of a fresh chicken in order to calculate a profit per unit for the ‘Packaged Chicken’ product.

Specifics

The most likely data from the example to be used to teach database concepts is the determination of profit for each product. Assume that raw materials that arrive today are placed in the display case for the next day’s sales. Also assume that a view of the database is created from database tables each day so that deliveries to the store can be tracked. The fields in the view are shown in Table 1. The combination of the purchase order number and the item number will uniquely identify every row in the view.

Students could be asked to construct a query to display all records of items corresponding to fresh chickens. A subsequent query question would be to find all fresh chicken items delivered on a specific date. That query requires a two constraints. To calculate the average price of fresh chickens delivered on a certain day requires a query that is constrained to a particular day, creates a new column containing the product of number of units multiplied by price, and then has the aggregated average of the prices. There are rich possibilities for many examples of simple and complicated queries.

From there could begin a discussion on which tables in the database could be needed to create the view. A further discussion about the possibility of multiple databases – one to support purchasing transactions, one to support calculation of demand for different products, and perhaps others.

Field Name	Description
Purchase Order Number	Corresponds to the purchase order number contained in the purchase order information system
Item Number	Corresponds to the item received (fresh chickens are number 220977)
Vendor	Vendor name selling the product
Number of Units	Number of individual units of the item in the order
Price	Price total of all the units of this item
Date of Delivery	Delivery date in date the format of YYYYMMDD

Table 1. Fields in the Delivery Records

CONCLUSION

Managers and professional staff are problem solvers. The pedagogy for the introductory information systems course should recognize this and create experiential learning opportunities that reflect a viewpoint of solving problems. There are skills taught in introductory IS courses that are associated with information systems majors, skill such as creating database queries. However, teaching that skill is less effective when taught as a stand-alone concept than when it is taught as one facet required in a problem solving method. This means instructors of the introductory IS course must consider assignments in the class as based upon a decision making process, how that process leads to solution, and finally as a platform for students to learn information systems skills.

Most students in the business school introductory IS course are not IS majors. While schools can use the introductory IS course as a platform to attract IS majors it is equally important that non-IS majors understand the role and importance of information systems in their disciplines. A large number of non-IS majors depend upon information systems every day to perform their tasks. They need to be taught more than information systems are a black box for which they input a few numbers and receive an answer. They need to understand and appreciate that the systems can be complex, require developers to understand the decision process, and lead to more profits for the organization.

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