
Sales and operations planning spreadsheet homework

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Abstract: This paper describes an Excel-based application that help teach students the aggregate operations planning portion of the sales and operations planning (S&OP) process. Randomly generated problems allow students as much practice as they need to master the material while reducing their ability to share their answers. The delayed feedback associated with traditional homework is eliminated because of the application's interactive nature. Under the application's guided direction, students can more easily practice calculations related to inventory, capacity, and production and explore the relationship between cost parameters and the relative attractiveness of chase and level production strategies. Instead of delving into individual calculations while grading homework done by hand, faculty can look at special verification information on the worksheets to quickly confirm that each student correctly completed his or her unique assignment. The various learning styles supported by the application are discussed.

Keywords: sales and operations planning; S&OP; SOP; aggregate planning; spreadsheets; Excel; academic integrity; cheating; Index of Learning Styles; ILS; VARK; teaching brief; operations management education; homework.

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1 Introduction

Sales and operations planning (commonly abbreviated as S&OP or SOP) is widely used because it is a “low risk, high payback venture” that works “so well in so many different companies” [Wallace, (2010), p.17]. S&OP aligns sales, marketing, operations, and finance plans with each other and with corporate strategy in order to develop a shared plan that drives decisions company-wide and helps balance supply and demand (Grimson and Pyke, 2007; Tavares Thomé et al., 2012). S&OP can help companies achieve a variety of benefits, including lower costs and better service (Grimson and Pyke, 2007; Tavares Thomé et al., 2012). Although specialised S&OP software is becoming more popular, many companies still use Microsoft Excel spreadsheets to support the quantitative portions of the process (Wallace, 2010). The S&OP literature review of Tavares Thomé et al. (2012) also noted that some authors have recommended relatively simple spreadsheets over more complex alternatives. Regardless, as with many operations management concepts, spreadsheets can be useful for quickly illustrating concepts and principles to students.

Grimson and Pyke (2007) and Jacobs et al. (2011) described the multi-step S&OP process. Although it varies from company to company, it often begins with the sales and marketing functions providing input to develop aggregated demand forecasts (e.g., on a monthly basis for each product family) that are unconstrained by capacity. The operations function then develops aggregated plans that consider the demand forecast, capacity, and carryover and safety stock inventory levels to determine production quantities and any capacity changes that will be made. Meetings are held to resolve differences between the functions and to finalise a company-wide plan that balances supply and demand. The operations portion of S&OP has traditionally been called aggregate planning, but the trend in many companies and publications is to recognise the cross-functional context of the overall process, and the S&OP term reflects that (Jacobs and Chase, 2008).

There are many aspects of S&OP that operations management courses might want to cover, including its overall context, the steps within the process, issues associated with cross-functional teamwork, potential collaboration with suppliers and customers, and how it can be used to foresee and prevent future supply and demand problems (Grimson and Pyke, 2007; Maloni and Franza, 2009; Wallace, 2010; Tavares Thomé et al., 2012). Learning the aggregate operations calculations helps students understand important concepts such as the drivers of the relative attractiveness of alternative production strategies and the relationships between demand, capacity, production, and inventory service levels. Students have traditionally practiced the aggregate operations calculations by using pencil and paper to complete the same homework problem(s) assigned for the entire class, after which they had to wait to receive instructor feedback.

While the traditional approach works fairly well, it is not without some shortcomings. Research has suggested that delayed feedback can be detrimental to student attitudes and learning (Kulik and Kulik, 1988). Tsai and Wardell (2006) wrote that if the same homework problem is assigned to all students, it is easier for them to collaborate together in undesirable ways, but the alternative of manually generating and grading separate problems can take a significant amount of time. Even without unique problems for each student, it can be time-consuming to grade S&OP homework manually because a mistake made in a calculation in one of the first months will affect the answers for later months; those later answers might be done correctly in light of the earlier mistake but differ from the answer keys.

This paper describes a spreadsheet application that can be used to help teach some of the quantitative operations planning aspects of S&OP. It offers a number of benefits for faculty and students compared to traditional pencil and paper homework and the basic S&OP spreadsheets included with some textbooks. Students can practice operations planning calculations, interactively explore the relationship between the cost parameters and the relative attractiveness of chase and level production strategies, and gain experience working with Excel to solve problems. Because problems are randomly generated, students can get as many opportunities to practice as they need to increase their confidence and mastery of the material. The delayed feedback associated with traditional homework is eliminated because of the application's helpful hints and interactive nature. Faculty can look at verification information on the worksheets to quickly confirm that each student correctly completed his or her unique homework assignment. Faculty may also appreciate the inclusion of a variety of features that promote academic integrity and make it easy for them to customise feedback and directions to students without the need to edit programming code. The application can be freely obtained by contacting the corresponding author.

2 Core functionality of the application

Because of the Visual Basic for Applications (VBA) macro code used to implement the application's functionality, the Windows version of Excel is required (it has been successfully tested with Excel 2007, 2010, and 2013). While the application assumes that students have at least basic Excel skills, it also has features that help make it easy to use. Tips remind students how to enable macros and use cell references and relevant Excel functions. Students are asked whether they want the application to automatically show a small hint next to each cell that explains the meaning of that S&OP datum. The hints are useful when first learning S&OP, but students can avoid reliance on them by later opting not to display them.

The cost parameters and data for the chase and level strategies are all on the same worksheet (see Figure 1), which facilitates understanding cost relationships and comparing and contrasting the strategies. The layout and fields are based on an example from Jacobs and Chase (2008). The application is coded to randomly generate demand forecasts that expose students to a variety of situations like stockouts, excess inventory, and the necessity of rounding up the number of workers required when no overtime is used. With the chase strategy, students meet fluctuating demand by incurring hiring and firing costs to adjust capacity, which in turn helps them avoid stockouts and excess

inventory. With the level strategy, students incur costs for stockouts and excess inventory because capacity and production are not adjusted to meet demand, but no hiring or firing costs are incurred because a constant number of workers are employed.

Figure 1 Partial screen shot showing level and chase strategies and a hint (see online version for colours)

	A	B	C	D	E	F	G	H	I	J	K	L
1	Hiring and training cost	\$140.00	\$ per worker		Units/Employee/Productive hour			2.50		Generate New Demand		
2	Layoff cost	\$100.00	\$ per worker		Productive hrs/worker/day			7				
3	Wages (8 hours per day per worker)	\$10.00	\$ per hour per worker		Beginning Inventory			1000		I Think I Am Done		
4	Inventory holding cost	\$3.00	\$ per unit per month		Beginning Workers			15				
5	Marginal cost of a stockout	\$3.50	\$ per unit per month		Safety Stock Percent			10%		Clear Circles		
6		January	February	March	April	May	June	Total				
7	Demand Forecast (in units)	6,868	5,204	2,024	10,801	1,099	8,276	34073				
8	# of Working Days per Month	22	19	21	21	22	20	125		Do NOT open this file directly from your web browser (e.g., from Blackboard, email, etc.); instead, save it to disk and open it from there.		
9	Safety Stock (in units)	667	520	202	1,080	110	828	3407				
10		Level Strategy										
11		January	February	March	April	May	June	Total Cost				
12	Beginning Inventory (in units)	1000										
13	Production Requirement (in units)											
14	Productive Hours Required											
15	Productive Hours / Worker / Month									Production Requirement This is how many units are required to be built this month so that forecasted demand will be satisfied and the safety stock will be left over (if the actual demand equals the forecast).		
16	Workers Required									Be sure to always enable macros when using this spreadsheet (every time you open it). The application will not work correctly otherwise. Make sure there is not a security warning beneath the ribbon; if there is, enable macros by clicking the Options button next to the warning (see the Macro Directions worksheet to the left of this one if it's not clear).		
17	Workers Hired											
18	Hiring and Training Cost											
19	Workers Laid Off											
20	Layoff Cost											
21	Labor Cost											
22	Actual Production (in units)											
23	Ending Inventory (in units)											
24	Excess Inventory Holding Cost											
25	Shortage Cost											
26		Total Relative Cost for Level Strategy										
27		Chase Strategy										
28		January	February	March	April	May	June	Total Cost				
29	Beginning Inventory (in units)											
30	Production Requirement (in units)											
31	Productive Hours Required											
32	Productive Hours / Worker / Month											
33	Workers Required											
34	Workers Hired											
35	Hiring and Training Cost											
36	Workers Laid Off											
37	Layoff Cost											
38	Labor Cost											
39	Actual Production (in units)											
40	Ending Inventory (in units)											
41	Excess Inventory Holding Cost											
42	Shortage Cost											
43		Total Relative Cost for Chase Strategy										
44		YOU ARE NOT DONE WITH THE HOMEWORK YET!!!										
45		Click the 'I Think I Am Done' button in the upper right corner of this sheet and follow the directions.										
46		Macro Directions / S&OP / S&OP Directions										

For each month of each strategy students calculate the beginning inventory, production requirement, productive hours required to meet the production requirement, productive hours per worker per month, workers required to meet the production requirement, workers hired and fired, hiring and firing costs, labor costs, units of production, ending inventory, excess inventory holding costs, and shortage costs. Cell validations check the answers and provide relevant feedback and suggestions if an incorrect formula is entered as students complete the worksheet. For example, Figure 2 shows the different messages that appear for the chase and level strategies if an incorrect number is entered for workers hired. As seen in Figure 3, the feedback can suggest the necessary formulas. Although Excel's standard validation functionality is limited to 225 characters for each feedback message, its key advantage compared to alternative approaches is that the feedback can be changed without modifying any code (see Figure 4) to suit the preferences of different instructors about how explicit to make the help for each message. The hints can be similarly modified using the 'Input Message' tab of the same data validation window.

Figure 2 Different feedback appears for the level and chase strategies if an incorrect entry is made for the number of workers hired (see online version for colours)

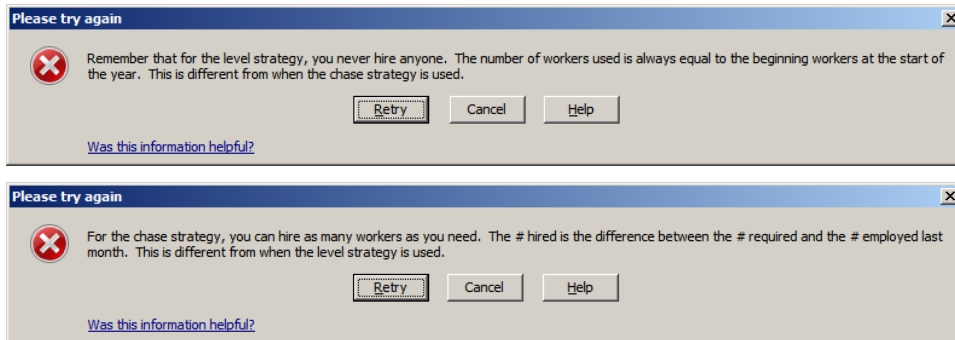


Figure 3 Feedback for an incorrect entry for a production requirement can include the necessary cell references (see online version for colours)

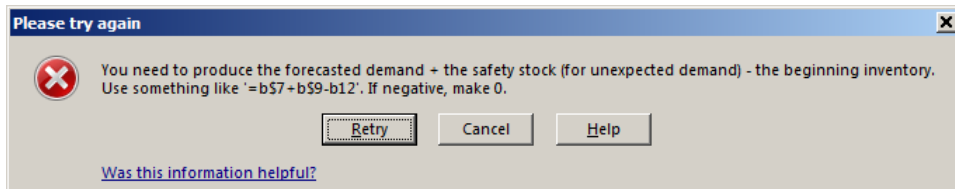
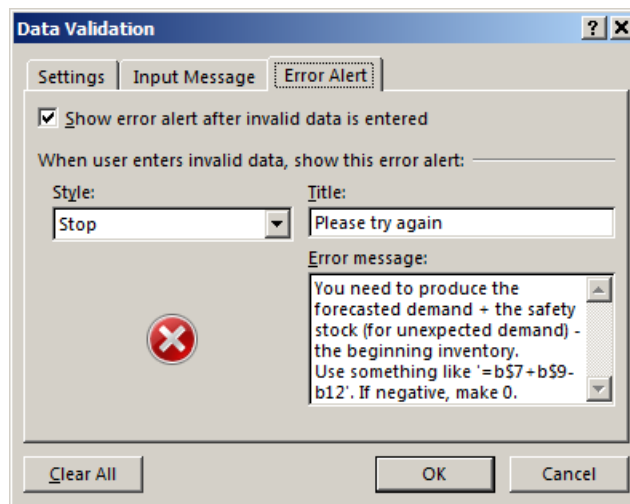


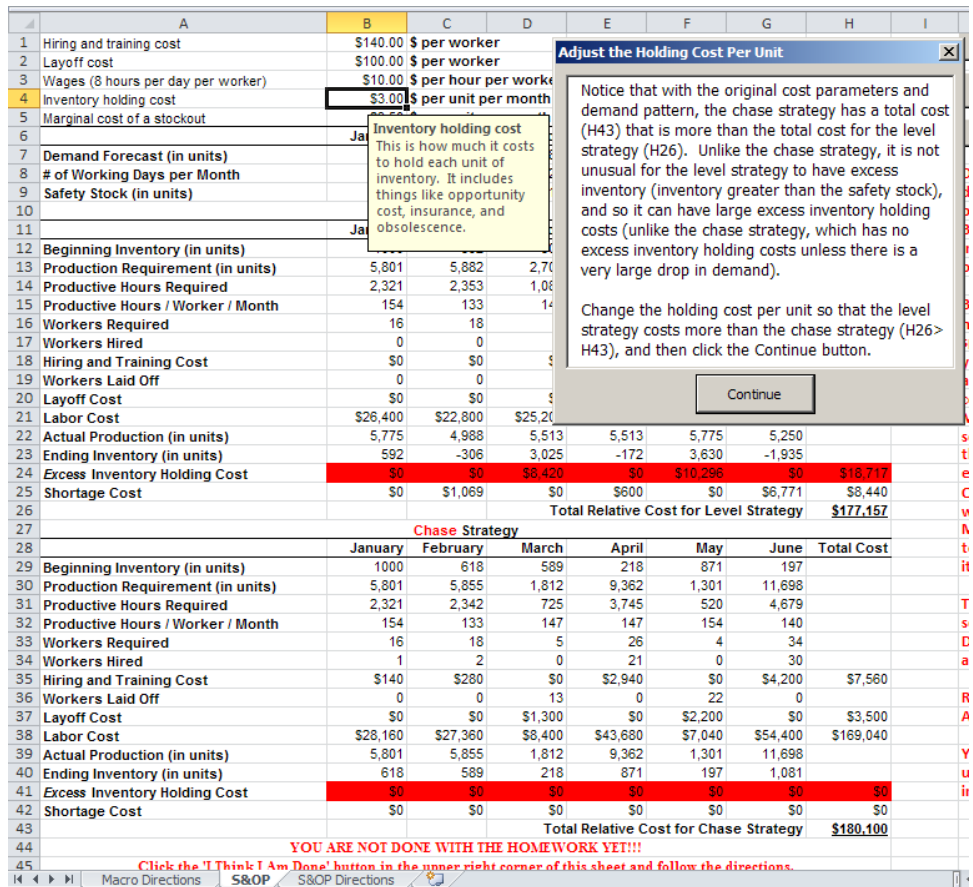
Figure 4 Hints and feedback can be easily modified with Excel's standard data validation functionality (i.e., without editing the application's program code) (see online version for colours)



To ensure proper checking of answers for each cell, it is important that the validation settings not be corrupted. Excel's standard pasting functionality would normally overwrite the validations in addition to the other contents (e.g., values or formulas) of the target cells. Rather than disabling pasting or relying on students to consistently use

Excel's 'Paste Special' functionality to avoid potentially corrupting cells, the application is made more robust by using special VBA coding to automatically prevent the validations from being overwritten when the normal pasting interfaces are used. Because the use of cut (unlike copy) would remove the validations from source cells, VBA and XML code are employed to disable attempts to access cut functionality via right-clicking, the keyboard, and Excel's ribbon. VBA code also temporarily protects the worksheet during file saves. If the student later reopens their homework to complete it, they will have to re-enable the macros (and thus re-enable the protection against corrupting the cells) before being able to edit their answers in the locked cells.

Figure 5 Partial screen shot showing prompts to adjust cost parameters that affect the relative attractiveness of the chase and level strategies while dynamically highlighting relevant rows (see online version for colours)



After the student has correctly entered the calculations for all of the cells (e.g., production requirements, workers required, actual production, ending inventory), he or she is asked by a series of interactive windows (see Figure 5) to change the per-unit holding and stockout costs and per-person hiring and firing costs in order to reverse the relative attractiveness of the chase and level strategies by sufficiently altering their total costs. The system automatically recalculates and highlights the changed costs for each strategy,

thus showing that the chase strategy is more attractive compared to the level strategy when per-unit stockout and holding costs are relatively high and per-person hiring and firing costs are relatively low, and the level strategy is more attractive in opposite cost parameter situations. With traditional pencil and paper exercises, re-computing the costs for each strategy by hand each time the cost parameters change would be cumbersome, provide diminished pedagogical value because students would have already performed the calculations for several months for each strategy at that point, and distract from the goal of showing at a high level how the cost parameters affect each strategy's attractiveness. As Ye and Zong (2006) noted, spreadsheets can help focus student learning on the most valuable learning goals, which is especially important in time-constrained courses.

The application ensures when the forecast is generated that this later stage of the homework will function as intended. The program's VBA code verifies that changing the cost parameters could make each strategy more attractive and automatically generates a different forecast if necessary. For example, a level strategy that is more expensive than the chase strategy with the original cost parameters can normally be made less expensive than the chase strategy if the holding cost per unit is made low enough (see Figure 5). If not for the special VBA code, forecasts could sometimes be randomly generated that would result in the chase strategy being less expensive even if the holding cost per unit was \$0 (e.g., if there were many shortages and the stockout cost per unit was sufficiently high).

Instructors demonstrating the application in class may not want to take the time to manually enter the calculations for all of the cells. To avoid taxing the attention span of students, instructors can complete as many cells as desired and then use a secret keystroke to execute a macro that automatically finishes any remaining calculations so that comparison of the alternative production strategies can begin.

3 Support for academic integrity

LaSalle (2009, p.108) noted that "instructors should be aware that out-of-class assignments, such as spreadsheet assignments...will likely be a low perception of detection condition and, therefore, relatively more prone to cheating than proctored exams. It would be quite naïve to think students would not cheat under such conditions ...". LaSalle (2009) also observed that leading students to believe that cheating will be detected can help prevent it.

The application has several features that are intended to help prevent and detect cheating while still allowing students to learn S&OP in a spreadsheet assignment format. When the application is started, a window reminds the students that they should not share or edit each other's spreadsheets and that they should submit different answers from one another because of the use of random forecast generation. When students complete the homework, a final message reminds them of submission directions and policies regarding collaboration. Although it is a simple technique, reminding students of the rules for completing homework reduces their ability to claim that they missed or did not understand expectations announced in class or in directions distributed outside of the application. To further discourage inappropriate conduct, the startup window notes that the student's username, computer name, and other related information will be stored with

the spreadsheet and printed. The opening and concluding messages can be easily modified by instructors (e.g., to indicate the submission deadline each semester, to reference the internet URL for their university's student handbook, etc.) by editing cells on a different worksheet in the application.

Cell locking in the password-protected worksheet prevents selecting or editing a message that indicates whether the homework has been completed correctly (see the bottom of Figure 1 or Figure 5). The message uses the Times New Roman font instead of the Arial font used in the rest of the cells. A student trying to create a forged spreadsheet might not notice the different font, thus providing a means for graders to identify attempts at deception. To help prevent copying formulas between students, the Windows clipboard used by copy and paste functionality is automatically cleared when switching between workbooks. As soon as the student has correctly entered all of the answers, the cells are locked and made inaccessible, and the 'show formulas' functionality is disabled.

After performing all of the homework steps, the header and footer are automatically set to include the user's login name and computer name, the date and time, and a code generated from the values in their unique assignment. While the code can be validated relatively quickly and easily while grading, many students will likely ignore it because it appears to be a meaningless number. If cheating takes place, most students will not know to put the correct code in place or how it is generated, and if they copy the code from another student, it is possible to determine with whom they collaborated.

4 Example course usage and support for multiple learning styles

The application has been used and enhanced over several years for undergraduate courses in introductory operations management and supply chain management at three different universities. The discussion below describes how the application has been used to enhance teaching S&OP in lecture-based sections, but it also been employed to help students learn independently without accompanying lectures. The lecture-based sections have typically taught S&OP at the end of the semester, so fluctuations in the time available have contributed to variation in the approaches used to cover the material.

Multiple learning styles are supported by the application, especially in the context of using it to supplement traditional class sessions. Much research has been done about learning styles, and many related assessments exist (Fleming and Mills, 1992; Beaudry et al., 2005; Zuckweiler and Cao, 2009; Gu et al., 2012; Sandman, 2014). It is commonly believed that when students are taught in a way that is compatible with their preferred learning styles, better outcomes such as increased learning and satisfaction will result (Zuckweiler and Cao, 2009; Gu et al., 2012; Sandman, 2014). Because of the range of learning styles, it is ideal for faculty to employ a range of means to help all of their students achieve success (Fleming and Mills, 1992; Felder and Silverman, 1988; Zuckweiler and Cao, 2009).

The Index of Learning Styles (ILS) assesses student learning preferences based on dimensions identified in Felder and Silverman (1988) and Felder and Spurlin (2005). The ILS dimensions are sensing/intuitive, visual/verbal, active/reflective, and sequential/global (Felder and Spurlin, 2005). As one of the ways to appeal to different learning styles, Felder and Silverman (1988, p.680) suggested, "Provide a balance of concrete information (facts, data, real or hypothetical experiments and their results) (sensing) and abstract concepts (principles, theories, mathematical models) (intuitive)."

While the majority of the time spent completing the spreadsheet immerses the students in the data, one of the most powerful features of the application is its interactive illustration of the principles of how the cost structures affect the relative attractiveness of each strategy. The accompanying lectures and slides also discuss the principles.

In the ILS instrument, visual learners prefer means such as diagrams, charts, and demonstrations, whereas verbal learners prefer written and spoken words (Felder, 2002; Felder and Spurlin, 2005). The application's hints and feedback and the accompanying slides and lecture discussions support verbal learning. The similarities and contrasts seen in the simultaneous display of the data for the chase and level strategies can be especially helpful for visual learners whether they see it in the in-class demonstration or as they complete the spreadsheet. Similarly, slide diagrams that contrast the chase and level strategies, illustrate the SOP planning process, and place it in the context of the planning hierarchy are also beneficial for visual learners.

Felder and Silverman (1988) wrote that some students learn best from actively doing something, whereas others learn more through reflection. Active learners benefit from completing the in-class printout and the application's interactive spreadsheet. Reflective learners benefit from being able to work on the material at their own pace, receiving feedback and help as necessary as they progress.

Felder and Silverman (1988) described global learners as learning non-sequentially and at a nonlinear rate, but most teaching supports the opposite. In part because of that, global learners may become frustrated as their peers often initially grasp the material more quickly (Felder and Silverman, 1988). To help global learners, Felder and Silverman (1988, p.679) suggested that "the instructor should provide the big picture or goal of a lesson before presenting the steps, doing as much as possible to establish the context and relevance of the subject matter Applications and 'what ifs' should be liberally furnished. The students should be given the freedom to devise their own methods of solving problems rather than being forced to adopt the professor's strategy" Before demonstrating the application, lecture slides help place S&OP in the context of classic planning hierarchy (e.g., strategic planning at the top, followed by S&OP, master production scheduling, etc.), illustrate the pros and cons of chase and level strategies, and present the multi-step high-level process of S&OP. The application facilitates 'what-if' analysis, and the validations do not require that the exact same formulas be used as long as the correct answer is obtained. As a means of supporting sequential learning, Felder and Silverman (1988, p.679) suggested using "drill exercises to provide practice in the basic methods being taught", which characterises much of the functionality of the application.

Felder (2002) noted that Felder and Silverman (1988) included an inductive/deductive learning dimension. He later found that students generally state that they prefer deductive learning (e.g., because it facilitates more clear-cut studying for tests), even though he personally felt that inductive learning is both more natural and effective for undergraduates (Felder, 2002). Felder and Silverman (1988, p.678) stated, "Much research supports the notion that the inductive teaching approach promotes effective learning". Felder and Spurlin (2005, p.105) noted, "The optimal teaching style is a balanced one in which all students are sometimes taught in a manner that matches their learning preferences, so that they are not too uncomfortable to learn effectively, and sometimes in the opposite manner, so they are forced to stretch and grow in directions they might be inclined to avoid if given the option." To avoid professors using student

preferences to justify relying on traditional deductive learning, the inductive/deductive dimension is not included in the ILS learning styles instrument (Felder, 2002).

The application supports learning through both induction and deduction. Instructors can easily modify the hints and feedback messages to be as general or specific as desired with information about the basic principles and specific formulas (e.g., see Figures 1 to 4). If students initially focus on the calculations, they can learn the basic principles and exceptions through induction, but if their preferred learning style is deduction, they can use relatively general information to learn the calculations. Felder and Silverman (1988, p.678) noted that it is unfortunate that students often do not get an inductive learning approach and thus “never get to see the real process – the false starts and blind alleys, the extensive trial-and error efforts that eventually lead to the elegant presentation in the book or on the board.” Printouts of blank S&OP spreadsheets are distributed to the students, and as the instructor uses a computer projector to talk through and demonstrate the calculations for each strategy, sometimes mistakes are made and corrected. The instructor stresses that it is much better to think about the basic logic associated with each calculation than to try to memorise formulas for each cell. Although the instructor gives them slides that describe the calculations in words (e.g., ‘Production requirements (in units) = demand forecast – beginning inventory + safety stock; If negative, make it zero’), they are covered after being illustrated by particulars. Similarly, much of the discussion of the key principles is after they have been illustrated with the in-class example.

Felder and Silverman (1988) noted that some of their recommendations, particularly those involving the use inductive learning and active learning, may add to the amount of time needed to cover material. Because the interactive nature of the application supports self-learning, less class time is needed to accomplish the same amount of active learning, and instructors demonstrating the application can quickly jump to the portion where changing the cost structure alters the relative attractiveness of the strategies without manually completing the cells beforehand, as noted at the end of Section 2. Felder and Silverman (1988) also note that sensors especially benefit from computer-based instruction. Several studies have found that business students are generally sensors (De Vita, 2001; Naik and Girish, 2012; Sandman, 2014), thus suggesting that the application is well-suited for its users.

The VARK categorisation scheme suggests that some students prefer to learn visually (V) through information that is represented graphically or symbolically (e.g., using diagrams, charts, color coding, highlighting, or special arrangements or structuring of information); others prefer to learn aurally (A) through means such as lectures, discussions, and tutorials; reading (R) and writing information as words (e.g. slides, books, or computer messages) is best for others; and some benefit most from multi-modal kinesthetic (K) learning that connects students to reality, through means such as learning by doing, practice, simulation, demonstrations, hands-on computing approaches, trial and error, and examples of principles (Fleming and Mills, 1992; Zuckweiler and Cao, 2009; Gu et al., 2012). The VARK website indicates that 28.3% of business students were kinesthetic learners, 25.3% preferred reading, 24.7% preferred aural learning, and 21.7% preferred visual learning (Fleming, 2014).

The application supports kinesthetic learning by letting students practice performing the calculations, often in a trial and error manner. There is corresponding classroom discussion about related real-world S&OP issues. During the in-class demonstration, students use pencil and paper to complete a printed version of the same spreadsheet that

the instructor projects on a screen. Much of the content in the application (e.g., the hints and feedback) and the accompanying lecture slides support learning through reading. Aural learners benefit from the lectures and classroom discussion. The structuring of the worksheet to easily compare and contrast the strategies and the dynamic highlighting of their relevant costs (e.g., see Figure 5) can be especially helpful for visual learners.

In fall 2013 and spring 2014, 82.98% of 141 students in five sections completed the homework on time, 7.09% completed it but submitted it late, 3.55% partially completed it and submitted it on time, and 6.38% did not submit anything. Students are typically asked to email their spreadsheets to the instructor. The instructor can then quickly validate whether the spreadsheet was completed, and the randomly generated forecast for a particular month is recorded for each student. Those recorded forecasts can then be easily sorted and checked for duplicate values. If by coincidence students have the same forecast for that month, it does not take long to go back to their emails and compare the rest of their spreadsheets and examine the validation codes and other recorded information.

Although students have sometimes submitted duplicate spreadsheets in previous semesters, it has been over a year since this has happened. From conversations with other faculty who use traditional spreadsheets without anti-cheating functionality, this is a great success. It is a balancing act to not offend students (e.g., by suggesting that they might cheat) while stressing the importance of not submitting duplicate spreadsheets and the corresponding likelihood that such cheating will be caught. After (admittedly dubious) student claims of not knowing the inappropriateness of submitting the same spreadsheet as others when using earlier versions of the application, additional and more direct messages were added. Because students may not always read messages, the issue is also raised in class, the slides, and the course management system used to distribute the spreadsheet to the students.

5 Student feedback

Students were surveyed during the first semester that the application was used. The average score for the question “After using the SOP Excel spreadsheet, I have a better understanding of SOP calculations and how the chase and level strategies work” was 4.11 (1 = strongly disagree, 5 = strongly agree). In an open-ended question about what they liked best about the application, 55% of the survey respondents mentioned the online hints and/or feedback.

At each university, students were expected to be proficient in Excel prior to taking the introductory operations management course. Nonetheless, before completing their homework some students expressed lack of confidence using Excel or uncertainty about appropriate functions and cell references. Although the primary emphasis of the application is learning quantitative aspects of S&OP and the impact of the cost parameters on the relative attractiveness of chase and level production strategies, the opportunity to reinforce basic Excel skills should not be overlooked. In response to the survey question ‘After using the Excel spreadsheet, I have a better understanding of Excel’, the average score was 3.86 on the aforementioned scale. Given the course prerequisites, this is perhaps a surprising finding that shows the secondary benefits for some students of using spreadsheets to teach operations management concepts.

6 Conclusions

Depending on the focus and extent of S&OP coverage, the capabilities of the students, and the time and technological resources available, other options for teaching S&OP might also be appropriate. For example, Maloni and Franza (2009) describe the use of a more open-ended project to demonstrate a real-world application of S&OP. Despite the popularity of using spreadsheets for S&OP, teaching students how to use specialised S&OP software may also be beneficial. From the authors' experience teaching with SAP enterprise resource planning (ERP) software, sometimes the complexity inherent in such systems can make it difficult to keep students focused on the primary operations management learning goals. Similarly, simulations can help expose students to sophisticated real-world interrelationships, but without a good understanding of basic issues and principles, the output may seem random to them. This application helps students develop a basic understanding of S&OP. As noted in the introduction, there are many other important S&OP issues that should be covered in addition to the quantitative operations aspects and the effect of the cost structure on the relative attractiveness of the strategies.

Spreadsheets are a natural tool to employ for a wide range of business and pedagogical needs, and opportunities exist to apply the techniques described in this paper to facilitate teaching and learning additional topics besides S&OP. Both faculty and students can benefit from spreadsheet applications that support multiple learning styles, dynamically generate problems, interactively provide help and feedback, encourage academic integrity, and make grading faster and easier compared to traditional paper-based assignments.

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