

Improved participant's learning through in-Class Inventory Management Simulation Game in business management and executive education program

Prof. Ketan R Gandhi

Visiting Faculty, SIBM Pune

Abstract

As instructors continue developing and mixing useful learning tools for their classrooms, games have become one of the popular alternatives in b-school education. This paper explains an inventory simulation game, evaluation of student's learning from playing the game and results. An effective game helps students understand concepts more quickly and remember them better than from only a faculty led lecture.

The game used here is a simulation of an inventory system, where student teams place orders for an item (Cricket Bat) on a monthly basis from manufacturer (based on limited knowledge of prior demand), update total stock adding new order item in opening stock at start of the month and then the instructor informs them what the demand/sale is for that month. There are holding costs for items not sold and shortage costs if they run out of items. The students then place their order for the next month. The game continues for 12 months. To evaluate student learning before-and-after questionnaire method was used. It allowed for an initial benchmark to be established, followed by a measure of how much students improved. For the questionnaire, answers were scored and compared between before game and after game to assess learning.

Most results point to the conclusion that students learned from the game. Basic inventory knowledge increased, students gained an appreciation for the complexity of inventory issues and of decision making in general and students enjoyed the game and thought it was a worthwhile learning experience. It was evident that many students grasped the larger strategic issues and were beginning to apply them more broadly. Although not all changes were statistically significant, most did improve, suggesting that students developed a deeper hands-on understanding of the issues. The current study is confirmatory in the general use of simulation games, although it adds to existing literature in that little exists on operations management games and their assessment.

Keywords

Assessment, Learning, Classroom, Games, Simulation, Operations Management, Pedagogical tools

Introduction

Games become more useful pedagogical tools today. IT infrastructure for developing and them and implementing them in the classroom has helped in adopting game as learning tool. Many instructors are using one or more games to enhance delivery of their courses, and successful games have been disseminated to others through various mediums. For example, Heineke & Meile (1995) developed an entire book devoted to games and exercises for teaching concepts in operations management. Although it is clear that students generally enjoy in-class games, it is at times unclear if learning occurs during these

exercises. It is difficult to separate learning that occurs during games from other forms of learning (e.g., lecture, reading the text, analyzing case studies, working on practical problems). Even if this is possible, there may not be class time available to carry out the assessment.

This study addresses both of these challenges in an experiment conducted in first year MBA class, considering learning outcomes from an inventory simulation game that was developed in 1996 at the University of Calgary modified in local product context. As the game has been disseminated over the years, it has been used at quite a number of B-schools in the introductory operations management class. Student progress can be tracked through computer or manual entry table which can be entered in computer later for analysis. Students are forced to understand and make rational decisions regarding a number of opposing aspects through time. Games of this type (simulation) can be used in various disciplines and topics and thus the results from this study should be generalized to other situations. The success of the game is based on positive student response to the exercise in terms of the deeper understanding they have of the complexity of decision-making and due to their enjoyment of it. It builds a context to teach Inventory management topic after the game has been played. The overall goal was to determine if the students achieved a better understanding of inventory management in general, and/or a better understanding of specific topics (e.g., how to make calculations and take decisions as Manager). When game is used in conjunction with other teaching including lecture and case study, it was evident that understanding of overall issue improved.

In a broad sense, the use of games as part of the educational environment fits into the philosophy of active learning and constructivism. In order to promote a deeper understanding of material, students ought to be engaged with what they are doing. Student-centered model of teaching through involving students as active participants results in a positive learning experience. Students of MBA program will be required to demonstrate their capability as manager during their study, cross functional subjects, and during their future employment. Learning is enhanced if students make decisions and then need to respond to the consequences of each decision. This habit helps students in their future assignments to make decision with more confidence. These exercises developed their abilities to solve problems systematically, perform forecasts in uncertain environments, and develop their team working abilities and to measure objectives.

This paper explains the inventory game used, review the methodology used (including development of the instruments) for evaluation and assessment, and report on results from the assessment.

Description of the Inventory Game

This inventory game is a simulation of a sporting goods retailer who needs to make appropriate ordering decisions for one type of cricket bat. Specifically, students decide when and how many cricket bat to order every month for an entire year. The game takes between 20 and 40 minutes of class time and was developed to:

- enhance learning
- experience for an enjoyable learning
- familiarize students with basic inventory concepts
- give students a chance to test their intuition

SAMVAD

- demonstrate to students how frustrating it can be to make decisions under uncertainty
- familiarize with challenges that managers or owners faces in real business world and their dilemmas

To play the game in class, students are divided into groups of 6-8 members each and are given the instructions. They are also provided with a worksheet to track their inventory levels through time. To start, opening stock is set as Zero and students determine their order quantity for the first month. Once all groups have reported their orders and the instructor has entered these on a spreadsheet (which is projected for the class through computer or writes on the board), the instructor informs students what the demand actually is for that month (pre-determined randomly, given the parameters). All teams calculate profit (or loss) for the month, after which groups plan their order for the next month. Throughout the game students and teams are not aware about profit to date of other teams and at the end of the game students compare their total profit to the maximum total that other team. They can also compare their profit with maximum profit have been achieved if they had known demand in advance.

There could be many modified versions of the game used in the class to learn many other concepts related to inventory management, forecasting, marketing-operations interface etc.

The Assessment Instruments

Developing effective assessment instruments proved to be a challenging task for a number of reasons. It was desirable to separate learning as a result of the game from the learning gained as a result of other pedagogical techniques used to teach this topic. Since the game is relatively short and is followed by lecture and case study analysis on the same topic, it would not work to simply test them at the end of the material. It was desirable to determine students' understanding before playing the game in order to compare it to knowledge after the game. Thus, it was undesirable to simply have a test at the end. In order to get accurate readings on relative before and after performance, it is best if the "before" results for each student can be compared to the "after" results for the same student. However, this may require knowing which student supplied which answers and which students had read the chapter materials (to see how much exposure they had to the content before the game). Students might be reluctant to give this information in the fear that it may be used for grading purposes. The game already uses a fair amount of class time; extra assessment activities will require even more of this scarce resource.

For evaluation of learning first questionnaire was given, the game was played, and the second questionnaire was given after the lecture session and case study analysis is completed. The questions were purposely very simple as it was assumed that students had never had any teaching on inventory management. On a side note, it was an interesting and somewhat unnerving experience for the students to do a "test" without having been taught anything about the material (they had read chapter from reference book and also case study prior to the class.)

First question on questionnaire was an attempt to understand if students understood the purpose of inventory management (the big picture) either before or after the game was played. Next Question tested whether they understood basic inventory concepts, particularly the concepts of stock remaining from a prior period, and running out of stock. This question was identical on the second questionnaire except different numbers were used. The third question tested students regarding relevant costs in an inventory

ordering decision. The fourth question was included to see if the understanding of complex business decisions made under uncertainty was enhanced through this exercise. The first questionnaire also asked if they had read the chapter or case study before the game, the assumption being that students that had read the material would have a better understanding. If so, this could be removed as a confounding factor. The second questionnaire had two additional questions, asking if the students thought it was a worthwhile experience (testing to see if they enjoyed it) and asking an open-ended question about the most important thing they learned from the game (to check broader understanding).

Students initially tend to think they should order every month (very little thinking initially about the balance between ordering costs and holding costs, not realizing that ordering costs are relatively high for small orders). The experiment was carried out in three different classes where more than 170 students attended their respective class. However total 152 students completed both questionnaires. Team's final profitability score is compared among all teams in the class. Top scoring and lowest scoring teams presented strategies they adopted from start till end and how they could achieve results.

Results

Questionnaires

Overall, the questionnaires revealed that students had a better understanding of inventory management issues after the game than before. For the first three questions the alternative hypothesis tested was whether students improved; whether they answered more accurately after the game. These three questions could potentially be treated as qualitative data, comparing the proportion correct after the game to the proportion correct before. However, once they are scored, it is equally valid to perform a quantitative analysis. Table 1 gives results for the first three questions. Microsoft Excel was used for all data manipulation.

Table 1 Result of before and after questionnaire for questions 1-3

Sr. No.	Potential Points (153 students)	Responses in Before game questionnaire A	Responses in Class questionnaire B
1	306	269	269
2	153	6	8
3	765	420	507

First, recall that students were not taught anything about inventory management before these questionnaires; thus, scores would be expected to be low, especially before the game. However most of the students have either read book chapter or case study or both. Students also reported not reading the inventory chapter or other material before the class. This was not unexpected, since this class met every week and there were many assignments they need to complete in other subjects during the week, reducing their opportunity to read the reference book or case study. The instructions for the game go over a few inventory concepts, but these are directly related to the game; they are not generalized. Questions 2 and 3 show strong evidence that there was improvement after the game. However, Question 1 gives no evidence of improvement in total (however few student's responses qualitatively improved in question 1). Since students have read reference book material and case study, they gained knowledge about purpose of inventory management.

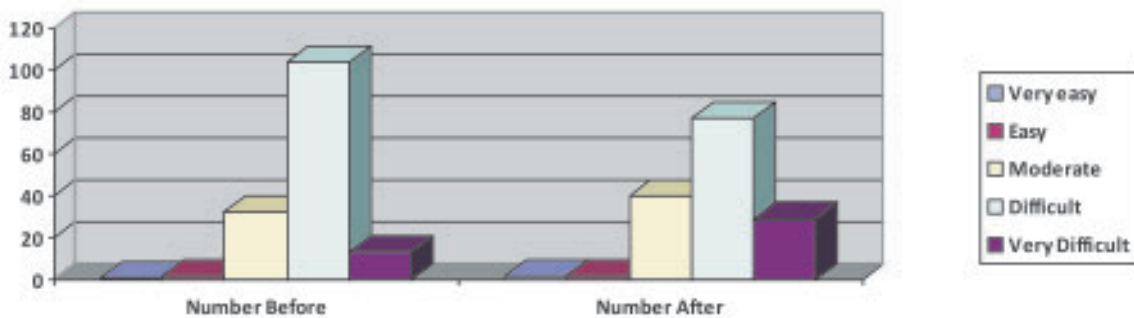
In question no. 2 very few students could give correct answer before or after game, one possible

confusing factor may be order is considered as available stock.

Questions 4 and 5 use ranked (or ordinal) data. Question 4 asked how difficult students feel inventory decisions are. It was included to see how students perceive the complexity of inventory-related decisions. It is felt this may also be an indication of their before and after understanding of business decisions in general; students may under-estimate the complexity of decisions in the real world. Since we have matched pairs, the sign test is most appropriate for this data, using the alternative hypothesis that students will feel it is more difficult after the game. The sign test is made possible by coding the responses from 1 to 5, with "very easy" being labeled 1 and "very difficult" being 5. Results are summarized in below table.

Table 2 Result of before and after questionnaire for question 4

Question 4	Number Before	Number After
Very easy	1	2
Easy	2	2
Moderate	32	40
Difficult	104	77
Very Difficult	13	29



The sign test reveals a significant change, with overwhelming evidence that students felt that inventory management was more complex after the game than they did before.

Question 5 (only on the second questionnaire) asked if the game was worthwhile, to get an indication whether students enjoyed and felt they learned from the game. As can be seen in Table 3, the vast majority felt the game was a very worthwhile learning experience.

Table 3 Result of before and after questionnaire for questions 4

Question 5	Number After	%
Not at all	1	1%
Somewhat	3	2%
Moderately	29	18%
Very Much	120	79%
Total	153	

In their responses to Question 6 (an open-ended question asking about the most important thing learned from the game), a few students mentioned very game-specific learning where as many students mentioned generalized concepts of inventory management. However, most students understood the wider applicability. A number of students pointed to the difficulty of predicting demand and some pointed to the need for analysis when making decisions (instead of just guessing). Others mentioned the importance of focusing on the long-term results, which is likely due to the fact that many groups start out with little profit or even losses at the beginning of the game, but by the end, all made a profit. There were many interesting responses in this question including less stock is not always profitable, set a profit target and then order etc.

Discussion and Concluding Remarks

All results (except one) point to the conclusion that students learned from the game. Basic inventory knowledge was tested in the first 3 questions on the questionnaire. Two of these showed significant improvement; one showed no improvement. However, these 3 questions may be less important than the rest of the results, as the rest tested on a more general, conceptual level. Question 4 showed that students gained an appreciation for the complexity of the issues and of decision making in general. Question 5 responses showed that students enjoyed the game and thought it was a worthwhile learning experience. Question 6 demonstrated that many students grasped the larger strategic issues and were beginning to apply them more broadly.

This demonstrates a deeper hands-on understanding of the issues necessary to do well in the game. Thus, this study has confirmed prior research that games are effective in enhancing learning. This study raises the interesting question of how to assess learning from a particular pedagogical technique or a mix of pedagogical techniques.

If time is available, we can assess learning from a particular pedagogical technique through before and after questionnaire by playing game twice in the same class, thus ensuring that no learning from other source occurs in between.

Similar studies by Kenneth J Klassen and Keith A Willoughby (2003) and research illustrates that students are more likely to remember the educational material learned from games than from a typical lecture. This may be the strongest reason to use games in the classroom. Besides this, students are likely to develop positive feelings toward a course in which games are used, thus improving the chance of paying attention and learning even during other class sessions. A possible drawback to in-class games is the time taken. In general, less material can be covered if a game is used.

Now considering the inventory game itself, this game meets all the goals mentioned earlier with the possible exception of one. Students gain specific and general conceptual knowledge about inventory, often realizing these through doing instead of by being told. They generate their own data by choosing the size and timing of orders, and the game has simple materials for students' use. The goal that may not be met is that it may not be low stress. Students work hard to make the correct decisions, some even using calculators to try and make better decisions. However, this turns out to be a good team exercise, where members need to rely on others to gain understanding. It is complex enough that few can grasp all decision factors on their own.

In fact, it may be desirable to develop games that can be completed in very short periods of time - a concept taught in 5 minutes may be the same as one taught in 20 minutes. Granted, there may be value in working on something over a longer period of time, but in any case, this may be an opportunity for future research.

In conclusion, simulation games provide good learning experiences because students make decisions, see the results of those decisions, and then need to make further decisions based on those results. Results are based on individual decisions as well as on the accumulation of all their decisions. Most simulations involve uncertainty; thus, they are useful tools to acquaint students with this aspect of decision-making.

References for further reading

1. Heineke, J. and Meile, L. (1995). *Games and exercises for operations management: hands-on learning activities for basic concepts and tools*. Englewood Cliffs, NJ: Prentice-Hall.
2. Kenneth J Klassen and Keith A Willoughby (2003). *Journal of Information Technology Education Volume 2, 2003*
3. Applefield, J.M., Huber, R.L. and Moallem, M. (2000). *Constructivism in theory and practice: toward a better understanding*. *High School Journal*, vol. 84, no. 2, pp. 35-46.
4. Bodo, P. (2002). *In-class simulations of the iterated prisoner's dilemma game*. *The Journal of Economic Education*, vol. 33, no. 3, pp. 207-216.
5. Doyle, D. and Brown, F.W. (2000). *Using a business simulation to teach applied skills - The benefits and the challenges of using student teams from multiple countries*. *Journal of European Industrial Training*, vol. 24, no. 6, pp. 330-342.
6. Faria, A.J. (1998). *Business simulation games: Current usage levels - An update*. *Simulation & Gaming*, vol. 29, no. 3, pp. 295-309.
7. Gremmen, H. and Potters, J. (1997). *Assessing the efficacy of gaming in economic education*. *The Journal of Economic Education*, 28, 4, pp. 291-303.
8. Heineke, J. & Meile, L. (2000). *Classroom service games*. *Presentation at the Decision Sciences Institute Annual Meeting*, Nov. 18.
9. Kohn, A. (1997). *Students don't 'work' - They learn*. *Education Week*, Sept. 3.
10. Kraiger, K. and Cannon-Bowers, J.A. (1995). *Measuring knowledge organization as a method for assessing learning during training*. *Human Factors*, vol. 37, no. 4, pp. 804-812.
11. Levine, B. (1998). *Leadout: An experience in leadership*. *Simulation & Gaming*, vol. 29, no. 3, pp. 367-369.
12. McCune, J. (1998). *The game of business*. *Management Review*. vol. 87, no. 2, pp. 56-58.
13. McKeachie, W. (1994). *Teaching tips: Strategies, research, and theory for college and university teachers*. Lexington, MA: D.C. Heath and Company.

14. Neal, D.J. (1997). *Group competitiveness and cohesion in a business simulation. Simulation & Gaming, vol. 28, no. 4, pp. 460-476.*
15. Passman, R. (2001). *Experiences with student-centered teaching and learning in high-stakes assessment environments. Education, vol. 122, no. 1, pp.189-199.*
16. Reall, M.J., Bailey, J.J. and Stoll, S.K. (1998). *Moral reasoning "on hold" during a competitive game. Journal of Business Ethics, vol. 17. no. 11, pp. 1205-1210.*
17. Santos, J. (2002). *Developing and implementing an internet-based financial system simulation game. The Journal of Economic Education, vol. 33, no. 1, pp. 31-40.*
18. Schwartzman, R. (1997). *Gaming serves as a model for improving learning. Education, vol. 118, no. 1, pp. 9-18.*
19. Silver, E., Pyke, D., and Peterson, R. (1998). *Inventory management and production planning and scheduling. New York: John Wiley & Sons.*
20. Teach, R. (1993). *What do we teach when we use games? In Percival, F.; Lodge, S.; and Saunders, D. (eds.) The Simulation and Gaming Yearbook. London: Kogan Page.*
21. Westbrook, J.I. and Braithwaite, J. (2001). *The health care game: An evaluation of a heuristic, web-based simulation. Journal of Interactive Learning Research, vol. 12, no. 1, pp. 89-100.*
22. Wolfe, J. and Chanin, M. (1993). *The integration of functional and strategic management skills in a business game learning environment. Simulation & Gaming, vol. 24, no. 1, pp. 34-46.*

