Assignment 08: Final Paper
CS-6460 Educational Technology

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Abstract — This project develops a set of Problem-Based Learning (PBL) modules called "Case Simulations" for economics and business students. Case Simulations are Case Studies with matching Market Simulations. Together, they provide a comprehensive PBL environment for students to explore economic phenomenon, analyze markets, and generate recommendations. Instructors can adapt the content to supplement textbooks, lectures, and class discussion. Case Simulations suit economic principles, business economics, market strategy, and pricing courses.

1 PROBLEM STATEMENT

> *The economy vs human life? "There are more important things than living", (Dan Patrick, Lieutenant Governor of Texas, 20 April 2020).*

It is indisputable that a healthy economy is important. Many believe that protecting the economy is more important than protecting human life. And yet our understanding of economics and how markets work is seriously lacking.

Economics trails only English Composition as the most popular course in USA universities, with 40% of all students taking at least one economics course during their career (Siegfried, 2000).

But the popularity of economics then drops from first to last, with only 2.3% of students obtaining an economics degree (Data USA, 2020). The education these students are receiving is clearly not meeting their expectations.

Many of these students redirect their focus towards a business education, which helps explain why business is the world's most popular undergraduate degree (National Center for Education Statistics, 2016-2017).

And yet, business students are also not being prepared with real-world skills.

All these students are taught about monopolies and perfect competition, and they receive an overview of the anti-trust laws governing oligopolies (Krugman, 2014). This education has not changed since at least 1955 (Samuelson, 1970). But students are not learning the real-world skills needed to manage competitive dynamics required by their future jobs.

Market problems are complex and ill-defined, making them difficult to teach through textbooks and mathematical frameworks. But these story and decision-making problems are well suited to Problem-Based Learning (Strobel, 2009).

Market simulation can enhance business and economic case studies by providing students with an immersive learning environment. Students can independently explore the phenomenon, propose solutions, test hypotheses, and develop the genuine work products that drive understanding (Hallinger, 2012).

Problem-Based Learning techniques that include both case studies and educational technology like market simulation can help students develop these critical economics skills (Ormerod, 2013).

2 WHY A PROBLEM BASED LEARNING SOLUTION

Problem Based Learning (PBL) is a constructionist learning approach in which students must confront a phenomenon they have observed but do not understand. Constructionist learning is effective because students build strong mental models around personally meaningful elements that come from the domain itself. This differs from traditional learning which attempts to build understanding more abstractly through such tools as mathematical models. (Aslan, 2020).

2.1 Scientific Method

According to Berger (1983), the problem-solving process is closely aligned with the scientific method. Both approximate these 8 steps:

1. Select a problem
2. Develop multiple hypotheses
3. Evaluate the merits of the hypotheses
4. Suggest the best hypothesis

5. Test the hypothesis
6. Gather feedback and draw conclusions
7. Compare conclusions with reality
8. Explain differences and identify new models

Berger (1983) was interested in the learning styles of students when they confront problems. He adapted the "Learning Style Inventory" from Kolb (1976) in which it was found that people could be categorized along two dimensions:

- People are either Active or Reflective learners, and
- People prefer learning using either Abstract or Concrete elements.

Using this two-by-two framework, Kolb was able to map the problem-solving process. Starting from the right-hand position (3 o'clock) and rotating clockwise, people select problems, test alternative hypotheses, gather feedback, and update their model of the phenomenon or solution.

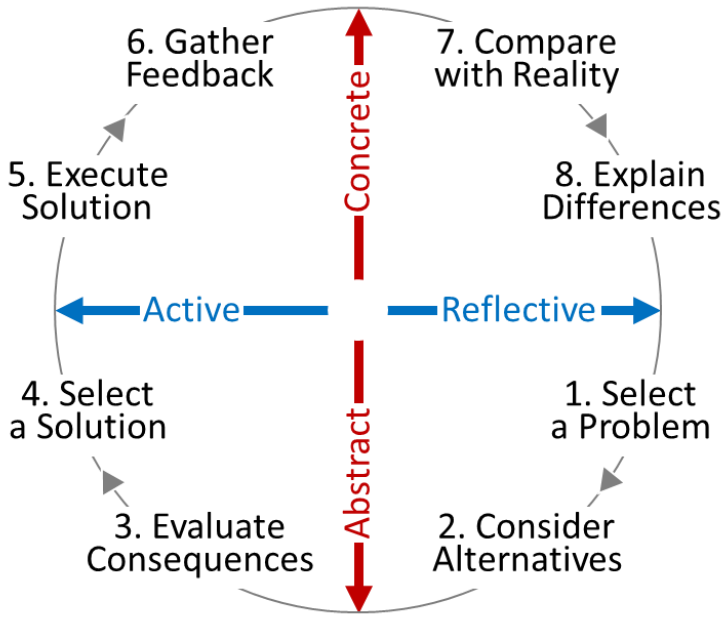


Figure 1: Problem Solving Cycle mapped onto the Learning Style Inventory by Kolb, Rubin and McIntyre (1979). The problem-solving process is aligned with the scientific method.

2.2 Case Method

Law schools were one of the first modern learning institutions to embrace problem-based learning techniques and have been using the Case Method since 1870. As Rakoff (2007) put it: Harvard Law School's methodology does not just predate the Internet – it predates the telephone!

The Case Method was introduced to help elevate the study of law to a science. It evolved from Socrates and focuses on reflective and abstract learning (Patterson, 1951) – placing it in the bottom-right corner of the Problem Solving Cycle.

But the method is now under attack as being "too scientific". According to Moskovitz (1992) law schools teach the *science* of law, but not the *practice* of law. Students never get a chance to do any active learning or work on anything concrete until the exam.

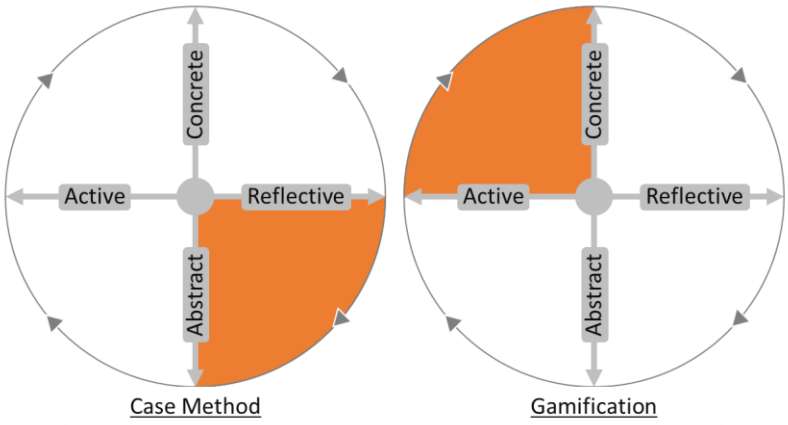


Figure 2: The Case Method and Gamification are narrow teaching methods focusing on opposite quadrants of the Problem-Solving Cycle. The Case Method offers only Reflective-Abstract learning, while Gamification offers only Active-Concrete learning.

2.3 Gamification

Gamification takes the opposite approach by de-emphasizing the abstract and reflective portions of problem solving.

When playing a game, be it a serious game or a recreational game, many players primarily operate within only the active and concrete portion of the problem-solving process: trying different solutions, evaluating feedback, and iterating.

Figure 3: Gamers primarily focus on the active/concrete portion of the Problem-Solving Cycle (steps 4 to 6), repeatedly trying specific alternatives until a winning solution is found.

Well-designed educational games will push students out of this narrow range of activities and encourage them to think about the bigger problem. These games will add *abstract* elements by challenging students to enumerate consequences (step 3). And they will inject *reflective* elements by asking students to compare their results with reality (step 7). But students playing problem-solving games can often find optimal solutions more quickly without abstract reflection through a process of rapid iteration (steps 4 to 6).

2.4 Business and Economics Learning Styles

Effective problem-based learning for economics and business students requires a holistic approach that cannot be so narrowly focused.

Kolb (1976) found correlations between student learning styles and their selection of occupation, then plotted these relationships onto the Learning Style Inventory. From this chart, Business Majors prefer active/concrete learning styles, while Economics Majors prefer reflective/abstract learning styles.

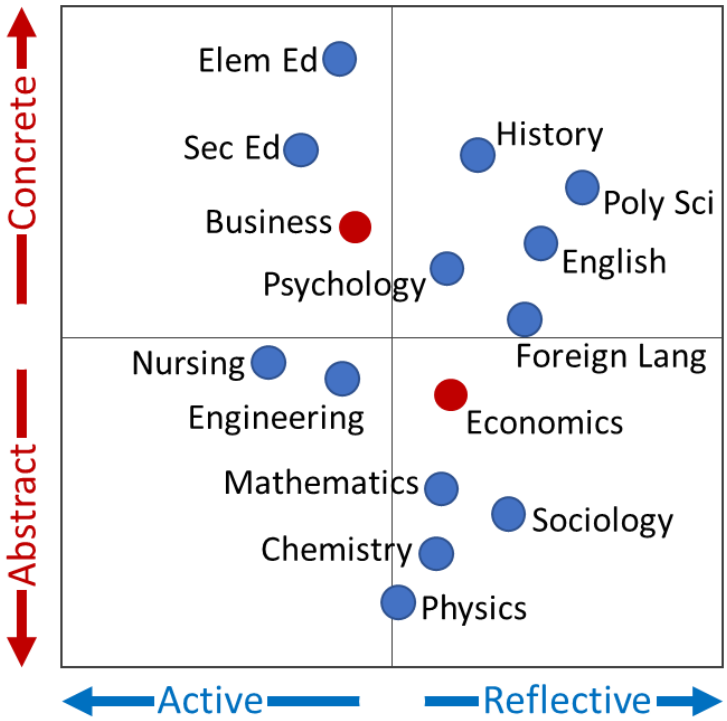


Figure 4: Student Majors vs Learning Style (Kolb, 1976). Business students prefer active/concrete learning styles, while Economics students prefer reflective/abstract styles.

Berger (1983) extended this work by finding that preferred learning styles are not immutable. Students can shift their problem-solving style depending upon the nature of the problem. Market problems involve real-world products, customers, and rivals, as well as optimization, empathy, and game theory. Hence all four quadrants must be addressed for learning to be completely effective.

2.5 Case Studies and Market Simulation

Rakoff (2007) praised the reflective teaching methods conducted by business schools and held up case studies as a model for law schools to follow. Case studies extend beyond the legal Case Method by allowing students to also reflect on more concrete and real-world problems.

But business school cases studies can often be vacuous. They lack analytical depth and any grounded method to challenge the insights and hypotheses of students. They also fail to provide the intrinsic learning motivation that comes from being an actor instead of a spectator (deCos, 2015).

Market simulation fills that void by providing Active Learning opportunities.

Active Learning gives students the chance to explore material in their own way and analyze the problem from many different perspectives (Fisher, 2014). With Active Learning, students are given information, but it is up to the students to do the analysis (Kunselman, 2004).

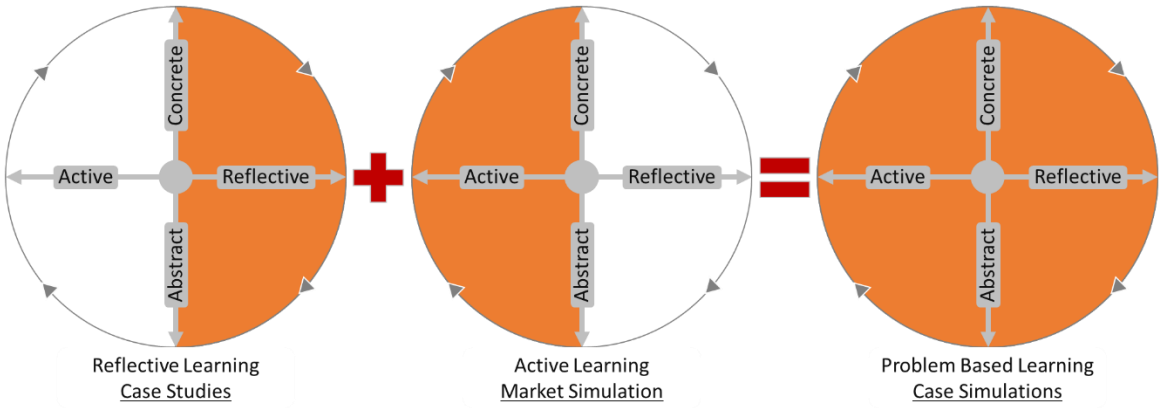


Figure 5: Case Studies + Market Simulation = Case Simulations. Together they offer comprehensive Problem-Based Learning.

3 RELATED WORK

The Scientific Strategy market simulator is the educational technology used to model the business and economic case studies developed in this project.

But case studies have been modeled in other ways. The NetLogo graphical programming language, the Mesa python library, and Microsoft Excel are three comparable technologies. Each is described below.

3.1 Scientific Strategy Market Simulator

The Scientific Strategy market simulator (www.scientificstrategy.com) has mainstream economic intelligence built-into its software. It has been used to analyze goods-and-services markets by students, academics, and strategy professionals.

Agent-based models (ABM) are assembled as graphical workflows within the open-source KNIME Analytics Platform (see figure below). This flexible framework allows almost any market phenomenon to be efficiently replicated.

Market models are built using domain elements, including: customers, products, brands, features, benefits, price, cost, value, stores, suppliers, distribution channels, and competitors. Mathematics, statistics, and coding are not required.

However, the KNIME Analytics Platform, along with important software extensions, must be downloaded and installed before they can be used by students.

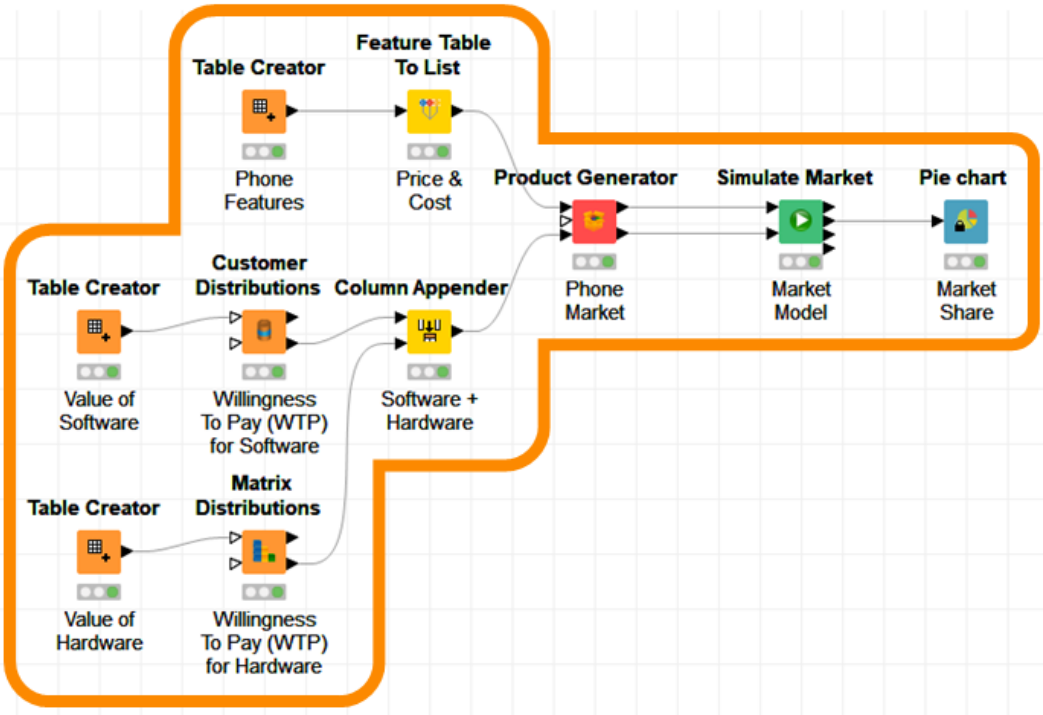


Figure 6: The Scientific Strategy market simulator allows the user to create market models from products, brands, features, benefits, price, cost, customers, rivals, and other domain elements. This simple example realistically replicates the mobile phone market.

3.2 NetLogo

NetLogo (http://ccl.northwestern.edu/netlogo/) is a browser-based programming language and integrated development environment (IDE) for agent-based modeling (ABM). It has been successfully used to simulate biology, computer science, environmental studies, and economic phenomenon (Hjorth, 2014).

Also an agent-based model, NetLogo can predict the behavior of agents within an environment when they encounter change. However, the software has no built-in understanding of economics and hence simulations are often unrealistic.

For example, in the NetLogo economics simulation below, firm agent "turtles" move randomly across a business landscape. If a firm crosses the green patch in the center, then the firm will lower its marginal costs and increase its competitive advantage (Kochanski, 2012). Unfortunately, none of these mechanisms realistically reflect the decision-making process of firms, or true dynamics of markets.

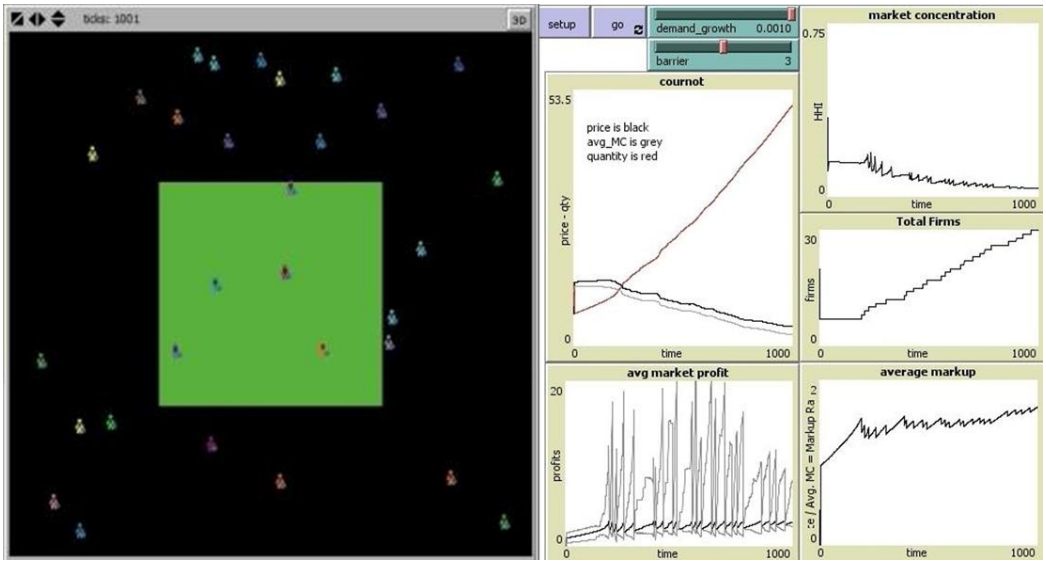


Figure 7: The general purpose NetLogo agent-based model allows students to develop simulations through a browser. But as NetLogo has no inherent understanding of economics, models are often unrealistic and limited to single phenomenon.

3.3 Mesa

Mesa (https://github.com/projectmesa/mesa) is a general-purpose, open-source, agent-based modeling framework in Python. Agents have attributes such as spatial grids and schedulers. But like NetLogo, it also has no inherent understanding of economics. Mesa models must be developed using abstract functions unrelated to the domain and phenomenon being studied (Benthall, 2020).

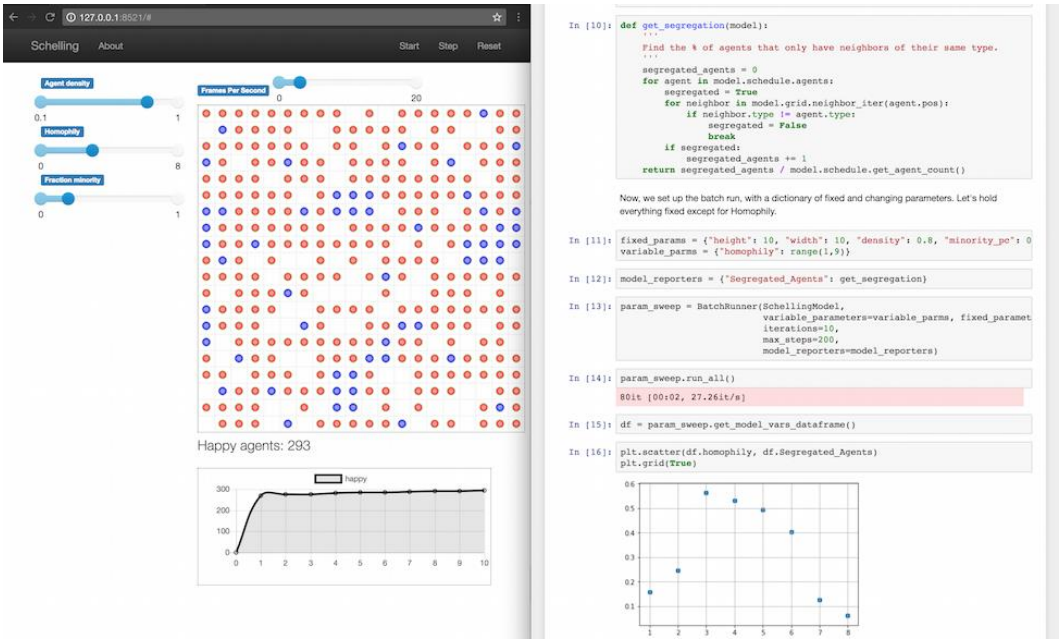


Figure 8: Mesa is a Python-based alternative to NetLogo. It is a general-purpose agent-based modeling environment. But models must be developed using abstract functions and terminology unrelated to the phenomenon being simulated.

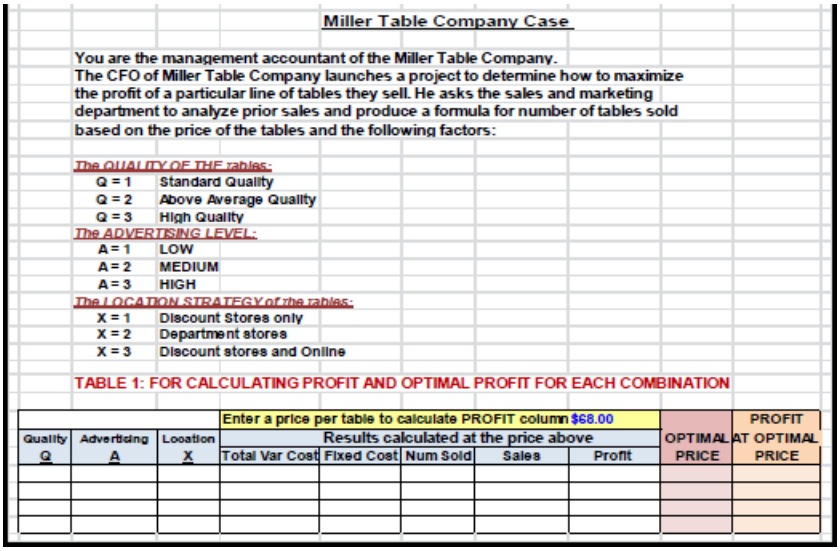
3.4 Microsoft Excel

Microsoft Excel is a popular tool used extensively by economists, business professionals, and students. It is well understood, has broad support, and requires no special installation.

Excel is often used in case studies. It is the centerpiece of the "Miller Table Company" business case (below) that was used successfully by students to analyze managerial accounting, economics, strategy, and marketing (Miller, 2013).

But like NetLogo and Mesa, Excel does not inherently understand economics. Mathematical models need to be coded through very limited, abstract functions. Their usefulness is limited to the single phenomenon being studied.

Furthermore, Excel is not an agent-based model. Scientific Strategy, NetLogo, and Mesa can all predict the behavior of customer and vendor agents when they are confronted with a changing environment. Excel cannot.



Miller Table Company Case

You are the management accountant of the Miller Table Company.
The CFO of Miller Table Company launches a project to determine how to maximize the profit of a particular line of tables they sell. He asks the sales and marketing department to analyze prior sales and produce a formula for number of tables sold based on the price of the tables and the following factors:

The QUALITY OF THE tables:
Q = 1 Standard Quality
Q = 2 Above Average Quality
Q = 3 High Quality
The ADVERTISING LEVEL:
A = 1 LOW
A = 2 MEDIUM
A = 3 HIGH
The LOCATION STRATEGY of the tables:
X = 1 Discount Stores only
X = 2 Department stores
X = 3 Discount stores and Online

TABLE 1: FOR CALCULATING PROFIT AND OPTIMAL PROFIT FOR EACH COMBINATION

			Enter a price per table to calculate PROFIT column $68.00						
Quality	Advertising	Location	Results calculated at the price above					OPTIMAL	PROFIT AT OPTIMAL
Q	A	X	Total Var Cost	Fixed Cost	Num Sold	Sales	Profit	PRICE	PRICE

Figure 9: Microsoft Excel is flexible and pervasive. But Excel does not inherently undertand economics, and is not an agent-based model that can predict changes in behavior.

4 DELIVERED WORK

I developed four Case Simulations that can be used to supplement courses in economics, business, and pricing. These Case Simulations all comprised of case studies with matching market simulations, along with instructor material.

4.1 Case Studies

The four case studies were developed from primary sources. Case study topics were selected to cover market competition, price optimization, new product development, and product assortment optimization:

- Burger Wars [Competition]
- Springsteen on Broadway [Price Optimization]
- Courtyard by Marriott [New Product Development]
- Foodie's [Product Assortment]

4.2 Market Simulations

Simulations replicating the market dynamics found in each of the cases were developed on the open-source KNIME Data Analytics Platform (www.knime.com) with the Scientific Strategy Market Simulation extension. This gives KNIME the economic intelligence that drives the agent-based model (ABM) underlying the simulations. This software extension was written by me and is freely available.

4.3 Instructor Material

Case Simulations help instructors be more successful. Problem-based learning (PBL) is a very effective teaching method when measured by long-term retention, skill development, and participant satisfaction (Strobel, 2009). And practice-by-doing offers ten-times more retention than lectures alone (Peng, 2016).

In addition to the case studies and market simulations, instructors are provided with teaching notes, PowerPoint slides, discussion questions, simulation questions, working models, answers, and postscript discussion notes.

4.4 Conclusion

Case Simulations provide a comprehensive PBL environment for students to explore economic phenomenon, analyze markets, and generate recommendations. Instructors can adapt the content to supplement textbooks, lectures, and class discussion to suit their teaching requirements and the learning styles of students.

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