A DATA-DRIVEN BUSINESS DECISION MAKING EDUCATION AND GROWTH SIMULATION PLATFORM USING ARTIFICIAL INTELLIGENCE AND 3D MODELING

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ABSTRACT

My research focuses on a gamified approach to teaching financial education, targeting students aged 10-18 [1]. I outline a method involving a simulated retail environment where players manage a retail store, enabling them to understand economic concepts through interactive gameplay. In my method analysis, I discuss three key algorithms: ordering items, tracking sales, and evaluating business performance. Each algorithm incorporates real-time data and complex calculations to simulate realistic retail operations, such as inventory management and sales probabilities based on customer foot traffic, location premium, and time of day. I aim to assess student preferences for this gamified learning model compared to traditional platforms like textbooks or Khan Academy, using a system of surveys to gather demographic information and feedback that provided excellent and satisfactory results [2]. The issue of financial literacy is urgent, highlighting statistics that reveal a significant knowledge gap in our youth.

KEYWORDS

Financial education, Gamified education, Retail simulation

1. INTRODUCTION

The problem that incentivized me to create this project was the distressing lack of financial education resources. In fact, over 89% of K-12 teachers agree that students should take a financial education course for high school graduation [3]. Financial knowledge is incredibly important, and yet only 27.2% of young people are considered "financially literate" [4]. This was shocking for me, the fact that actual adults were out in the world without any knowledge of how economics works. This problem mainly affects high school students without any financial knowledge. Oftentimes, without an understanding of basic financial concepts, they are not only unable to make good investments, but also lack entrepreneurial skills and knowledge on how to run a business efficiently and effectively. As a world that in the modern day has become centered around the founding of large businesses and the promotion of an entrepreneurial spirit, the lack of knowledge that the youth has on these subjects means that economic systems are dangerously at risk, and businesses may not be as successful as before [15]. In addition, after current high schoolers grow up, without knowledge about how financial systems work, they may find themselves struggling with identifying fair prices and having effective spending and budgeting habits, which could hurt them in the long run [5].

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Both my retail system and other academic research that I encountered focused on improving customer satisfaction and business model innovation [6]. In the first comparison, the research emphasizes stock availability as a key driver of retail satisfaction, but my system takes a broader approach, incorporating real-time solutions such as predictive stock management, personalization, and customer behavior analysis that the research paper just doesn't provide [7]. The academic research is theoretical. In the second comparison, the study of digitalization in retail reviews past trends and identifies future research needs, while my system provides immediate, actionable applications. Finally, in the comparison of small retail store, the research highlights basic stock management in rural stores. My system, however, is more advanced, using real-time analytics and actually takes into consideration a variety of stores, not just urban ones, including ones at city center, suburban, etc.

My app's purpose is to gamify financial and economical education and make it fun for people to learn. Although I could've made a normal financial education application, often times high schoolers prefer a video game that they can play instead [8]. As such, my solution is unique because rather than putting financial curriculum into normal form, I gamify it. By integrating tooltips and making the player run an actual retail store, my strategy is to immerse the player in a fun, educational experience that allows them to explore what decisions they should make and what concepts are behind them, rather than making them try to memorize as much information as possible. Players are tasked with managing their own retail store, allowing them to experience real-world financial decision-making in a fun, immersive environment.

My solution is way more effective than the other ones proposed because it makes educational resources far more accessible to a younger populace. Kids would prefer video games over reading a book, and my project is a far better way to appeal to that demographic. In addition, it's much more accessible as it is available on both phones and computers.

Address 3 major potential concerns that could arise as a result of the project. Chief among these are the coordinating of orders with the timer, where people argue that games don't accurately reflect real time processes - however the game highlights that although certain processes may vary, the app uses a structured timer system to simulate typical retail timing conditions as well as an accurate shipping fee to represent the way retailers work in real life. In addition, the probability of purchase by any customers could also be targeted by critics for its accuracy, but we use a formula based on real-world business calculation, using price and cost of goods sold, as well as considering the location premium and time of day and foot traffic. We were also met with challenges about realistic price fluctuations of products, but we have algorithms balancing those.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Coordinating Orders with Timer

Sample Skeptical Question: How can you be sure that your application represents accurate retail statistics related to time when it's just a game? After all, in real life everything takes time, and during some times processes happen faster than others.

Sample Response:

Great question! We can't exactly replicate the behaviors of shipping in real-life, but we can come pretty close. We implemented a timer for various products for them to arrive in your inventory

after being ordered, or the shipping time, as well as an additional shipping cost to make sure that realism is met. We try to simulate it as close to real-life processes as possible.

2.2. Probability of Purchase by Customer

Sample Skeptical Question: How can you be sure that your retail system provides an accurate representation of how people will purchase products? There isn't really an accurate model for purchasing behaviors.

Sample Response: Absolutely, but there is one but comes very close. We use a formula that businesses in the real world use to calculate the likeliness of a customer to purchase a product at any given time given the price of the product compared to the COGS price [9]. This allows us to get a relatively good representation of the average customer, and means that the user will have to set realistic prices.

2.3. Realistic Price Fluctuations of Products

Sample Skeptical Question: So in real life, goods normally don't stay at the same price forever, right? There's always going to be tiny changes up and down based on supply and demand, as well as economic factors like inflation or deflation.

Sample Response: That is true, but we've accounted for that level of unpredictability in our algorithm representing buying from suppliers. When consumers purchase from a company's supply chain that sends a product, the game will take into account the COGS range of the product that is set beforehand, with usually a plus or minus 20% deviation, and then create a random order price for that to represent the market.

3. SOLUTION

At the start of the game, the user begins with time paused and in the map screen. They can navigate this system using the WASD keys and their mouse to move around the map. After doing so, they can select a retail store that they want to own, and can make a purchase on it to set it as their own property. After they do this, they can open up 3 separate screens - the Sales Report, inventory, and the order/reordering screen. The first one computes the total sales of the user as well as their net loss/profit based on the amount of money they have spent on property and products so far. On the other side is the Inventory, which uses a complex system to keep track of the objects that they user has so far and allows the user to sell the products that they do have. This happens through a backend sales script and a search system, which allows the user to search through their products to find the item that they want, and upon selecting the item and quantity, the sales script uses a complex algorithm to find buyers at random times [10]. Finally, the order/reordering screen allows the user to purchase certain quantities of new items by looking through a category. As soon as they order an item, the render script runs, and connected to the same timer, when unpaused, runs another algorithm to ensure that the products are delivered in a realistic timeframe, and only when the timer is up.

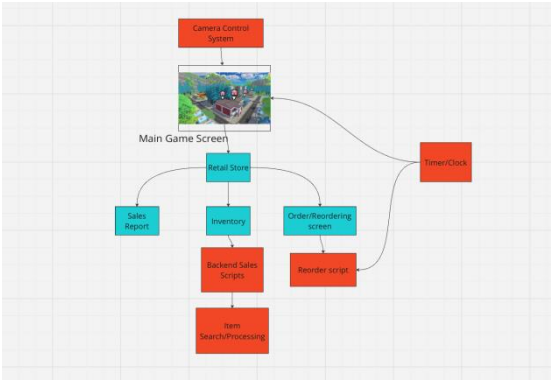

Figure 1. Overview of the solution

When ordering an item from the store, the user can click a button on the inventory menu to initiate an ordering process, which checks through the amount ordered of a product, current capacity and price, before running a coroutine to purchase the product, which is then shifted over to their inventory.

Figure 2. Screenshot of the game 1

```
public void OrderItem(RetailItem retailItem, int quantity)
{
    if(inventory.capacity + quantity > RetailRenter.Instance.myRetailBuilding.capacity)
    {
        print($"Cannot order {retailItem.itemName} x{quantity} because you're at capacity!");
        capacityWarningPanel.SetActive(true);
        return;
    }

    RetailInventory.InventoryStock findStock = inventory.GetStockByItem(retailItem);
    float shippingCost = findStock.shippingCost;
    float totalCost = (quantity * findStock.cogsPrice) + shippingCost;

    if(MoneyManager.Instance.money < totalCost)
    {
        print($"You do not have enough money to order x{quantity} + {shippingCost.ToString("F2")}
        return;
    }

    MoneyManager.Instance.ChangeMoney(-totalCost);
    RetailBusiness.Instance.AddToMoneySpentOnOrdersToday(totalCost);
    StartCoroutine(ReorderRoutine(retailItem, quantity, findStock.cogsPrice));
}
```

Figure 3. Screenshot of code 1

The function takes in 2 arguments when clicked - the item assigned to it and the quantity of the item ordered. If the capacity of the inventory at the moment and the quantity ordered is larger than the capacity of the building that the user is located in, the code informs the user that they are at capacity. The same goes for the lack of funds. The game looks through the stock inventory to obtain the retail item and obtain its total cost (cogsprice + shippingcost). If it is more than the player's funds, the purchase fails. Otherwise, it takes away the amount of money from the player's account and adds the item to the order list, where it is then processed and shipped out,

while at the same time looking backwards through the supply chain to pull information about the product and the company to forward to the inventory.

This is an algorithm that uses a formula and an integrated timer to track as time passes and calculate the likelihood for passing individuals to purchase a product given the price set by the user. We used a proven formula for engagement based on the possibilities of time, location, and premium.

Figure 4. Screenshot of the game 2

```
int CalculateCurrentTraffic(float locationPremium, int trafficLevel)
{
    int scaledTraffic = (int)(baseTraffic * locationPremium * trafficLevel * 0.5);
    return scaledTraffic;
}

float CalculatePurchaseProbability(RetailInventory.InventoryStock stock)
{
    // Calculate the markup percentage
    float markupPercentage = (stock.sellPrice - stock.cogsPrice) / stock.cogsPrice;

    // Calculate price attractiveness based on how close the selling price is to COGS
    // Assuming customers perceive lower markups as more attractive deals
    float priceAttractiveness = 1.0f - markupPercentage; // More attractive if markup is low

    // Clamp the price attractiveness to ensure it remains within realistic bounds
    float clampedProbability = Mathf.Clamp(priceAttractiveness, 0.01f, 0.9f);

    return clampedProbability; // Return the probability, clamped between 10% and 90%
}

int GetTrafficLevel(System.DateTime currentTime)
{
    int hour = currentTime.Hour;

    if (hour >= 7 && hour < 10) // 7 AM to 10 AM
        return 2;
    else if (hour >= 10 && hour < 15) // 10 AM to 3 PM
        return 3;
    else if (hour >= 15 && hour < 22) // 3 PM to 10 PM
        return 1;
    else
        return 0; // No traffic outside of 7 AM to 10 PM
}
```

Figure 5. Screenshot of code 2

The functions used in this process took in a number of variables and calculated one thing - the likelihood of consumers to purchase the item and the frequency. With the retail front having a traffic level representing foot traffic, the first function uses a factor function to combine the multipliers of premium and foot traffic to the base traffic amount, before scaling it and multiplying it by 0.5. The CalculatePurchaseProbability function also takes into account the price the player is demanding in comparison to the actual COGS price of the product, before returning the probability. GetTrafficLevel takes in the real-time of the game, and calculates what time of the day it is, and how many people will frequent the user's shop at that time, marking a peak hour at 10 AM to 3 PM and dropping off after that, which reduces the likelihood of purchase.

This code creates a system where the user can head over to it at any time and check the current status of their business, including sales revenue, gross profit, and more. It also lists the days in the past in a compact chart, and shows all statistics.

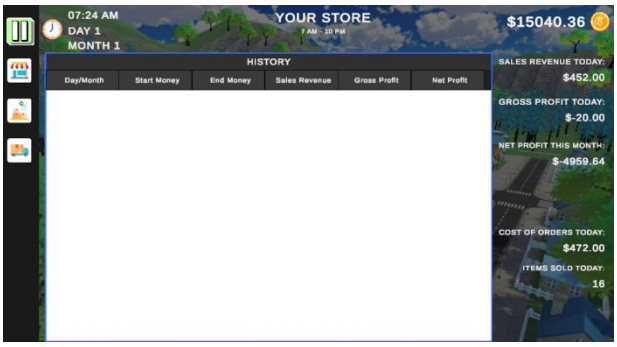

Figure 6. Screenshot of the game 3

```
public void SellItem(RetailInventory.InventoryStock stockItem, int amount)
{
    if (inventory.RemoveItemFromInventory(stockItem.itemData, amount))   // "Hey customer, we have
    {
        float totalPrice = stockItem.sellPrice * amount;
        stockHistories.Find(x => x.itemData == stockItem.itemData).sold += amount;
        MoneyManager.Instance.ChangeMoney(totalPrice);

        AddToTodayStockHistory(stockItem, sold: amount);

        print($"Sold x{amount} of {stockItem.itemData.itemName} for ${totalPrice}.");
    }
    else
    {
        print($"Failed to sell x{amount} of {stockItem.itemData.itemName} because you have {stockI
    }
}

public void AddToStockHistory(RetailInventory.InventoryStock stock)
{
    foreach (var s in stockHistories) // Look through current history, and find the existing stock
    {
        if (s.itemData == stock.itemData)
        {
            s.SetProperties(stock);
            return;
        }
    }
```

Figure 7. Screenshot of code 3

Here, although not containing the whole piece of code, shows how this script combines a series of retail functions to calculate end statistics. Here, when an item is sold (or multiple), it finds the total price it is sold for, before adding the money to the player's account and adding the selling record to the history. Otherwise, it fails because the player does not have enough stock. Further down the line, it takes into account the calculations of the statistics needed, including profit, revenue, and loss. In this case, the total price would be added to the total revenue, and compounded into the total profit and displayed on the screen for the player. This is achieved by running it through a function which then passes it on to be displayed on the UI canvas to the player, which then logs it when the time hits the registered month and provides a summary.

4. EXPERIMENT

4.1. Experiment 1

Evaluating whether students from an age range 10-18 would prefer a gamified model of learning economics and finance compared to other platforms (Khan Academy, textbooks), as well as the results of playing the game in providing knowledge about economic concepts compared to presurvey. Conduct a survey of around 25-50 people and record the results.

Reach out to various individuals via email and send them a link to them game download. Ask them to play for 10-15 minutes to explore the general game and features, before sending them a survey asking them what they would prefer if they had an option between the game that they just played and other options. In this case, the survey will also include gender, age group, and other

demographic information to ensure that as many variables as possible are collected. Next, we take the results and compile it into a database, before processing it.

Response	Enjoyment (0-10)	Preference over other platforms?	Recommend to a Friend?	Pregame Knowledge (0-10)	Postgame Knowledge
1	6	"Yes, more fun and engaging"	No	5	10
2	10	"Yes, useful"	Yes	4	8
3	4	"Both platforms have different strengths"		6	8
4	9	"Yes, more interactive"	No	4	10
5	7	"Like both equally"	Yes	5	10
6	10	"Yes"	Yes	3	8
7	8	"Platforms like Khan Academy go more in depth but I like this"	Yes	6	9
8	10	"Yes, simpler explanations	Yes	4	8
9	10	"I like the game"	Yes	5	7
10	8	"Not sure"	Yes	3	6
11	9	"Definitely"	Yes	6	8
12	10	"I'm getting this on my phone when it comes out"	Yes	4	10
13	8	"Not sure, both have good content"	Yes	5	9

Figure 8. Table of experiment

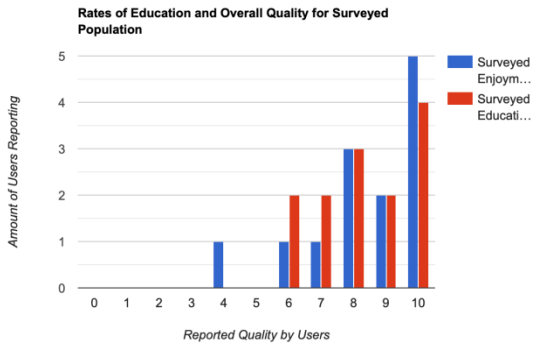

Figure 9. Rates of education and overall quality for surveyed population

As a result of 13 people surveyed after playing the game, we asked them to judge their overall enjoyment of the game, and asked a variety of questions, including whether or not they would prefer this over other platforms or recommend it to a friend. The results were largely satisfactory, with many individuals giving a score of 7+, and with all players reporting an increase in knowledge of financial concepts after playing the game and score improvements of 2 or above, even players that reported the game was not up to their standards, and . All except 2 also stated that they would recommend the game to their friends. As a result, observations indicate that this gamification succeeded in its role of improving financial education with high enjoyment rates amongst individuals that were surveyed, as well as some that would even prefer it over already existing platforms such as Khan Academy.

5. RELATED WORK

Similarities:

Both this research and my system focus on customer satisfaction in retail settings [11]. Both projects likely use data analysis or statistical modeling to understand the key drivers of satisfaction in retail.

Differences:
While this paper analyzes two specific types of stores and focuses on stock availability as the key factor, my system may take a broader approach.

My system may offer actionable solutions to improve stock management and satisfaction in real time, such as predictive analytics to avoid stockouts.

My system could be better in practical application by directly addressing the problem (e.g., stockouts) using predictive models or inventory management tools.

Similarities:

Both my project and this research focus on digitalization in retail and how it impacts business models [12]. Both likely use some form of data analysis to track trends and behaviors in a retail setting.

Differences:

My system seems to focus more on programmed solutions (such as machine learning models for customer behavior) that offer immediate, practical applications.

My system has direct real-world implementations with specific tools (like predictive models or sentiment analysis), while the research paper is more about mapping existing research and finding theoretical gaps. My system provides hands-on solutions, whereas the paper contributes to a scholarly understanding.

Similarities:

Both my system focuses on stock management, forecasting, and transaction tracking to improve efficiency and profitability [13].

Both approaches aim to address the lack of advanced digital solutions in small retail stores.

Differences:

The paper's focus is primarily on small retail stores in rural areas, where basic technology might be lacking. My system has a broader scope, integrating more advanced features beyond stock management and transaction tracking, such as customer behavior analysis.

My system may already have implemented the features the research identifies as necessary, such as AI-powered stock management, but with more sophisticated tools for real-time analytics and business intelligence. The study suggests these features as future needs, but my system might already offer a comprehensive suite of retail management tools that go beyond the basic needs identified by small retailers in the study.

6. CONCLUSIONS

Although my system is relatively well developed, there is still room for improvement in simulating multi-business operations more successfully [14]. As of now, the player can only purchase 1 business and run it from there, whereas in real life multi-business operations are more than common.

In addition, there also could have been significant improvements in the accuracy of customer behavior. Although this already does account for a lot of details, including items such as time, premium, price, and place, there can be better algorithms to simulate scenarios like this, and can add more accuracy, such as demand due to online trends and other factors that are actually very common in real life. We also thought about implementing a random-time shipping system, but eventually due to the complexity we had to opt out.

It would also be a better experience for the player if the game also had enhanced visuals representing each individual purchase or the way that customers interact with the world. Visual updates wouldn't be necessary, but being able to have people move around in front of a store would be great, and would definitely be able to boost the interaction of players with the game since it adds more diversity and life to gameplay.

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