Learning by Learning Roles: a virtual role-playing environment for tutoring

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Abstract

People will invest extraordinary time and effort into learning how to play and win a game. Virtual role-playing environments can be a powerful mechanism of instruction, provided they are constructed such that learning how to play and win the game contributes to a player's understanding of real-world concepts and procedures.

This paper describes a pedagogical architecture and an implemented application where students assume a role in a simulated multi-media environment and learn about the real world by competing with other players. The game, which teaches principles of micro-economics, is an implementation of a networked, multi-player, simulation-based, interactive multi-media, educational environment that illustrates the principles of learning by learning roles.

Keywords:

1. Architectures for Intelligent Tutoring;
2. Teaching and Learning Strategies;
3. Design Issues;
4. Real-world Applications

Introduction

Marshall McLuhan (1964) maintained that 20th century people do not want goals so much as they want roles. Authentic simulated environments enable learners to assume roles in particular contexts and have meaningful, near-real experiences. When these experiences are structured and arranged, even loosely, such that playing a role in the environment can illustrate the important concepts and procedures of the simulated domain, students are able to "learn by doing" (Dewey, 1900). Experiences are the best teachers.

Meanwhile, the value of play in learning can hardly be over-stressed. Students quickly tire of rigid tutorial systems designed to teach at any cost and at some predetermined pace (Schank, 1991). However, since simulations can be adaptive and responsive, playing a role in a simulation can be fun. Players will throw themselves terrier-like into an environment if it feels like a game. Insofar as possible, educational software should be engaging, entertaining, attractive, interactive, and flexible: in short, game-like.

Designing educational games is an exercise in balancing trade-offs. Educational content should be foremost, but not by occluding playability and simple fun. Simulated situations should be familiar, or at least easily recognizable, but not at the cost of slavishly replicating all the tedious detail of "real life". Experience in the simulated environment should be authentic, but not utterly predictable. Further, we believe that educational technology should capitalize on the natural human propensity for role-playing. Students will be willing to assume roles if the environment promotes that cognitive mind-set by making it easy to do, and if the environment reinforces role-playing through careful crafting of the explicit tutorial components of the game.

Finally, in to support student learning by learning roles, the tutorial components of a simulated environment should only present conceptual and procedural instruction within their strategic contexts. In other words, the goal in a role-playing environment should mirror the goals of a mythical law school professor: "We are not here to teach you the law, we are here to teach you to think like a lawyer."

This paper describes a networked, multi-player, simulation-based, interactive multi-media, educational game constructed on the principles listed above. The pedagogical domain is micro-economics, in particular retailing. The teaching goals revolve around the strategic importance of "targeting" specific customer groups in order to gain competitive advantage in the retail marketplace. The game is called **"Sell!"**; the point of the game is to make money.

The premise of the game is that the player has inherited a sum of money from a long-lost uncle --- but the bequest is on condition they go to the old home town of Springfield and enter the retail economy by taking over the family store. Thus the player is immediately assigned a well-defined role --- shopkeeper.

The architecture of the virtual role-playing simulation was designed to meet the following criteria:

1. The role of the player should be explicit from the outset;
2. The player's success at learning their role in the environment should translate directly into their success at playing the game;
3. Player actions should have a "real" effect on the simulated environment and the environment should react in realistic ways;
4. The simulated environment should be unintrusively pro-active --- the system should be watchful and active, but the player should always be in control of the experience;
5. The simulated environment should be rich, complex, and filled with interesting and yet plausible detail;
6. Complexity in the environment should be limited to those tasks and functions that relate directly to the teaching goals of the system --- other elements should be trivial, or used for diversion and purely entertainment purposes;
7. Interfaces should be easy to use and obviously representative of the environment being simulated --- the simulated environment should be visually iconic and metaphorical rather than photo-realistic, in order to promote the player's "willing suspension of disbelief"

(immersion) and further their acceptance of their role in the environment;

8. Finally, of course, players should be able to receive context sensitive help and advice at virtually any point in the game.

The teaching goals of the system are for the player to learn about marketing so they can compete for sales. Everything the student needs to know is available in the form of video advice and online help. Everything the player needs to succeed is available somewhere in the system. As a first approximation towards learner assessment, the student is said to have mastered the material if they succeed in quadrupling their "inheritance".

The Simulated Town of Springfield

The town of Springfield is simulated by building a graphical user-interface onto a MOO ("MUD, Object-Oriented", where MUD stands for "Multi-User Domain"). MUDs are typically text-based electronic meeting places where players build societies and fantasy environments, and interact with each other (Curtis 1992). Technically, a MUD is a multi-user database and messaging system. The basic components are "rooms" with "exits", "containers" and "players". MUDs support the object management and inter-player messaging that is required for multi-player games, and at the same time provide a programming language for writing the simulation and customizing the MUD. One of the major shortcomings of MUDs, however, is their low-tech communication system: text. The Sell! game supplies a graphical user interface layered on top of the networked multi-user database and messaging system that MUDs provide.

The town of Springfield is built out of an "entryway room" visually represented as a map of Springfield, which is divided into 8 neighborhoods. Every store in town is visible on the map and is implemented as a "room" within a neighborhood. Stores are located on the streets (which are also "rooms", albeit long, thin ones), and players are free to leave their store and visit others, either by

moving up and down the streets outside their store, or by "zooming" up to the map and clicking a store icon to visit it (see figure 1).

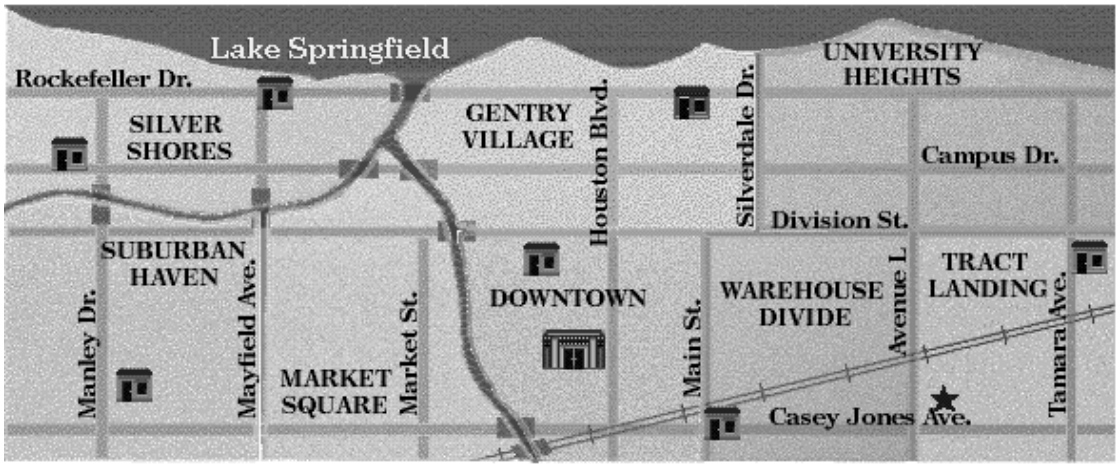

Fig. 1: The map of Springfield

Roaming the city is both fun and useful. Players are encouraged to keep track of their competition (this is one of the principles of successful marketing, and perfectly consistent with the storekeeper's role), and one straightforward way of doing this is to visit competitors and check their prices. In addition, each neighborhood has its own unique characteristics, that players can only experience by visiting. The players who find themselves in financial trouble can arrange a loan, but must visit the Downtown Bank to do so.

Fig. 2: The interior of a store.

It is important that the environment be sufficiently iconic, because icons impart more (metaphorical) information than photo-realistic images, and because they promote the willing assumption of role and character within the simulated environment (Crawford, 1990). It is also important that the metaphor be consistent and believable. For example, the spatial metaphor is preserved in the city of Springfield, but the map, which is useful by itself as a map, is also a "transporter" device for instantaneous travel.

The following is a breakdown of the spatial metaphor and its corresponding user interface components (in MUD, user interface, and domain order):

1. **A Room = a Window = a Context:** The room is the place where things are, and where things happen. The room is the context in which game activity takes place. As such, its visual representation should be nothing more that a visual cue to the user that certain activities can take place there. This is done simply by providing a background picture. Just as we can assume functionality when we walk into a kitchen or a bank, we should also be able to assume functionality if a picture of a kitchen or a bank pops up on the screen (see figure 2)..
2. **An Object = an Icon = an Object:** The object is the fundamental agent that can be acted upon. Objects represent things you can view and manipulate. Objects can be manipulated by clicking, double-clicking, dragging, dropping, selecting, and so forth. Objects in a room are represented by icons on a bitmap that can be acted upon. The valid actions, and their meanings, are determined by the MUD. The MUD accepts commands like "click" and "dragto x y". Players and containers are objects.
3. **An Exit = a Button = a Context Change:** Exits are used to leave and enter rooms. Since a room is a context, an exit is used to change context.
4. **An Action = a Button = a Function:** Some activities can be performed without requiring an object to be acted

upon, yet still occur within a context. These functions are effected by buttons.

Playing the Game: Learning to Compete for Sales in Springfield

In the current version of the game, the players each "inherit" a store and an initial stake of disposable cash ($25,000 in the current version of the game); the store is located in a randomly assigned neighborhood and is stocked with a small inventory of products (in the current version, either sporting goods or consumer electronics).

The initial store configuration is deliberately constructed to be a stagnant one; i.e. their store is in "trouble", and if the player does nothing to improve their competitive position, their products will not sell and they will lose the game. It is intended that competing in the game will encourage players to learn their role, and thereby learn the fundamental principles behind retailing.

Since our domain is the selling of products in a retail market, the essential concepts are simply stated: supply and demand, budgeting, competition, and marketing. In Springfield, supply is mainly taken care of by the players. They decide what they will sell, where they will attempt to sell it, and for how much. So, to learn to predict sales and maximize profits, the player must learn about the demand for their product in one of several ways: trial-and-error, market research, or from experiences with similar products or markets.

Springfield consists of neighborhoods occupied by population groups who might want or require different products. Its members are classified based on a combination of different demographic (age, income, education, etc.), psychographic (social class, lifestyle, etc.), and behavioral (use of and attitude toward product) characteristics. Since it is very unlikely that a player's store will be able to serve all of the customers in Springfield, the player must research these markets in order to target products and advertising to the appropriate groups within that market.

For example, instead of selling every product the simulation makes available, a player will need to pick segments of the market to

reach. If the target groups are to be lower-middle class families and college students (because, say, they are the predominant population groups in the player's local neighborhood), then the player should concentrate on selling economically priced bicycles and related products, not high-end surround-sound luxury televisions

In advertising for the product, the player will want to emphasize the bicycle's affordibility. In addition, advertising should be bought from the appropriate radio stations and publications (i.e. the college newspaper): those the target audience is likely to watch and read. Once a player prospers they may also want to expand by targeting additional population segments and developing different product lines and advertising campaigns to match those segments.

Further, the player may have competitors (or potential competitors) in those areas and will need to research them --- in order to either market products slightly differently (with lower cost or different product features) or attempt to reach an untapped market segment in another area. Finally, all of this must take place while the player is tracking the store's finances

In the game, players are able to do many of the things real retailers do. Players can buy advertising (on radio or in newspapers), and plan special promotional features (like sponsoring a softball team). They can order products from a variety of distributors and shop around for better prices and volume discounts. They can explore the city, checking the competition and do market research looking for likely customers. They can review their accounts, hire and fire staff, read the newspaper, "listen" to the radio, return slow moving stock to the distributor, and change their prices. And at any point they can stop and ask for help in various forms or seek expert advice. They can even change their own appearance.

It is important the environment have enough veracity that the role-playing experience is authentic and predictable in useful ways; i.e. a realistic economic simulation that responds to realistic events like advertising and price lowering. It is also important that the simulation itself be "inspectable" at some level, so that players can learn to predict the effect of their actions on the simulation. In the game, a market research tool (described below) is provided which

gives the players an interpretable look at the inner workings of the economic model, to enable them to make plans and plot strategies based on reliable information.

The Economic Simulation

It is important that the economic simulation be sufficiently realistic that players can learn to count on their actions having explainable effects on their results. It is crucial to the teaching goals of the system that players be rewarded for effectively learning their roles by success in the game. It is equally important that the simulation be transparent at some level so that players can inspect the inner workings well enough to make strategic generalizations about the environment, and to pass beyond trial-and-error problem-solving.

An economic model was developed to generate consumer behavior for the game. The model takes as input the decisions the players have made, and returns a level of demand for each of the stores. In the game, players compete for market share against other human players trying to learn the same role in the simulated environment.

Different areas of Springfield are home to different types of people with different wants, interests, and media viewing habits. A retailer, in order to succeed in this game, must match business strategy to target population, while also taking into account the activities of competitors. Springfield is composed of eight neighborhoods, each with a spatial orientation relative to the others. Sellers must search for population groups receptive to their business.

Neighborhoods are composed of several homogeneous population groups such as:

- "Up-scale-Urban-Couples/Homeowners/Highly-Educated",
- "Younger/Large-Families/Blue-Collar-Laborers",
- "Center-City/Middle-Age/Low-Income/Fewer Kids/Female-Headed-House", and
- "College-Student".

Each Neighborhood also has physical features that may influence the level of demand for certain products. For example, an

area called Gentry Village is an upper middle-class area with a large number of young singles and a low number of married couples with children. Gentry Village has bike facilities (i.e. bike paths) which increase the Neighborhood's potential demand for bikes.

To play the game, players must assume their role and make decisions which will determine their success or failure in the market place. The must decide what to sell, how much stock to buy, what prices to set, what service level to set, what level and type of advertising to buy, and, in future versions of the game, where to locate.

The major pedagogical goal of the game is to teach "targeting", which is a retailer's effort at matching their goods and services to particular "target groups" in order to maximize efficiency and profitability. In the economic simulation of Springfield, the underlying effect of a player's targeting is to adjust the simulated consumer's real cost. Real cost is not only price, but also transportation and search costs; also, real cost accounts for the benefits from service and added features or discounts. A store that offers the lowest real costs to a consumer group will win a majority of that groups business (and this is the underlying lesson for the player to learn). The game adopts the economic assumption that consumers are utility maximizers and cost minimizers (i.e. they try to get the most for their dollar) while allowing for considerable variation in what is valued by different consumer groups.

The Market Research Tool (MRT) is a particularly important component of the game since it enables the player to view the economic model in a useful way. In particular, the MRT allows the player to

1. identify buyers (population groups) interested in particular products;
2. identify complementary products the same buyers will also want;
3. identify the advertising media most likely to reach those buyers; and
4. find those buyers geographically on the map.

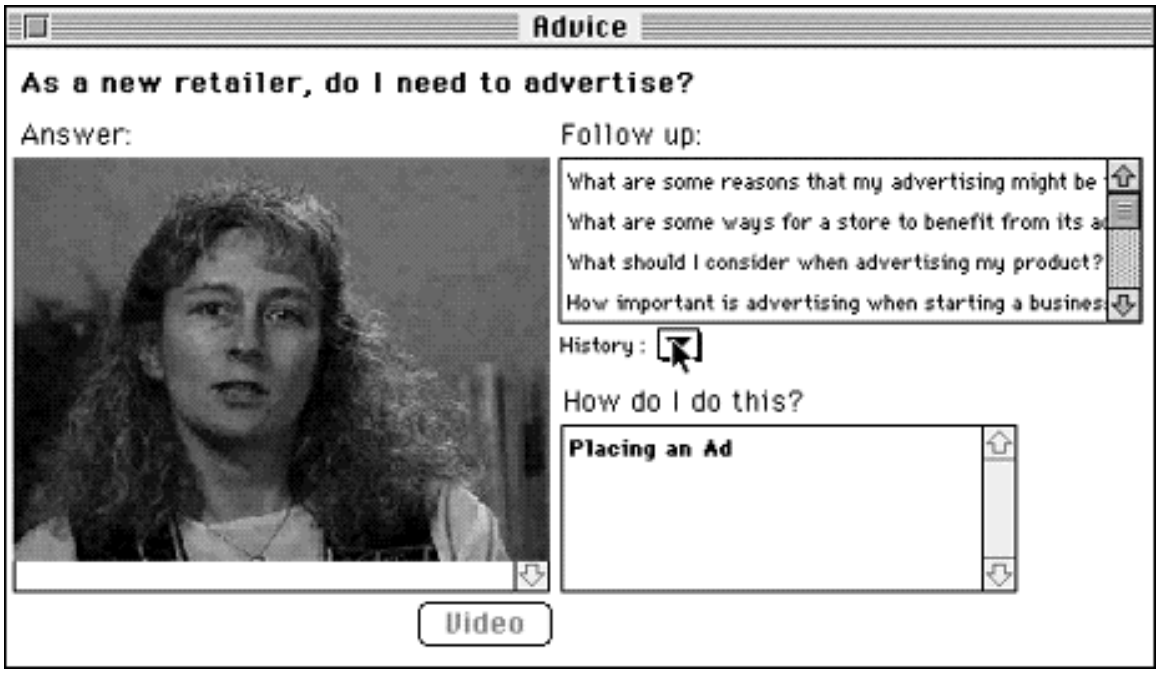

Fig. 3: The advice browser

The Pro-active Environment: Help and Advice

Information about the real world is offered to the player through the help and advice network (see figure 3), modeled loosely on the Ask System (Ferguson et al., 1992). These interfaces allow the player to ask subject matter experts (SME's) pertinent questions. The information offered by the SME's is in the form of video and text. It consists of theoretical principles that guide business decisions, examples of how these theoretical concepts are applied, and personal experiences or stories. It is, however, up to the player to determine how to use this knowledge in the game. The SME's currently consist of an advertising executive, a marketing professor, a corporate marketing professional, a banker, and a bike store manager.

The SMEs are accessible in two ways, either through advice buttons, which are ubiquitous throughout the program, or through the intervention of the pro-active tutor.

The advice system is context-sensitive which promotes the player's acceptance of their role in the game. For example, if the player is using the advertising interface, pressing the advice button

will take them into the advice network at a video clip answering the question,

° "As a new retailer, do I need to advertise?".

The video answer, delivered by the advertising executive, covers the fundamental issues of understanding who the customers are in order to choose advertising that appeals to the right groups.

In addition, following the Ask System model, the player is given the opportunity to ask follow-up questions like,

° "What are some reasons that my advertising might be ignored?"

° "What are some ways for a store to benefit from its advertising""

° "What should I consider when advertising my products?"

° "How important is advertising when starting a business?"

The video answer, again delivered by the advertising executive, outlines the dangers of over-extending an advertising campaign to a point where it's not cost-effective.

Again following the Ask System model, every video clip answers a question, and every answer has further follow-up questions. The user is free to browse as they choose. Further, every video clip in the advice network is connected to context-sensitive help, which explains how the real-world advice in the browsing network translates into actions in the game.

The Pro-active Environment: Tutoring

Perhaps the most important element of the educational environment is the pro-active tutoring component. This is effected by implementing a set of rules about retailing, and having the simulation monitor player actions, looking for rules to be "broken". For example, a player may decide to try and maximize profits by pricing their products at ten times the wholesale price. This is a naive strategy that says, "I might not sell very many, but each sale will be very profitable". The simulation recognizes this as a losing strategy and knows the player is unlikely to sell anything at all.

When the game detects a strategic mistake it sends a message to the player saying, "You may be setting your prices too high". The

player can then decide to ignore the message or pursue it. This unintrusive method of tutoring is implemented to be consistent with the educational game principles of leaving the player in control and letting them make their own mistakes. If the player chooses to pursue the warning, they click on the message and are taken into the tutorial section of the advice network at a video clip answering the question,

° "How do retailers set prices?",

which explains the ideas of profit margin and Manufacturers Suggested Retail Price (MSRP). The special tutorial lessons provide context and explanations, and serve as tutorial bridges to the advice network. Once the player is in the advice network, they may browse through the content matter to the extent they choose.

There is no penalty for ignoring the tutor's warnings, other than the inevitable failure to sell anything, a penalty imposed by the simulation as a consequence of the player's failure to learn their role in the environment. In all cases it is up to the player to decide how the warnings and advice apply to them. The simulation allows the player to win or lose in any way they choose. It is important the environment be an active one, where the player is stimulated by the events occurring in the game. The environment is not just a passive, reactive one, it seeks opportunities to interact and tutor. This model of opportunistic tutoring can be found in the Teaching Executive of Jona (Jona 1995) and in Burke's SPIEL (Burke 1993).

A common problem with simulations is that, like the real world, players can foul things up and not know why. Unlike the real world, though, all the information for the simulation is readily available, and can be used to generate explanations or warnings. Rules are based on the design and information in the model, and are fired by user actions. When a rule fires, the player sees a warning; they can ask for more information (bringing them to the Advice Network), or they can ignore it and carry on at their own risk. The idea is that the Proactive Tutor is that guy looking over your shoulder as you play. He should be there when you need him, but when you know what you're doing (or when you think you know), you can ignore him.

The Pro-active Environment: Other "Players"

Another key component of player stimulation in the active environment is the multi-player capability which maintains interest through real interaction and competition with other players. However, it is important the other players, be they human or automaton, appear at the same interface level --- as icons to be manipulated and understood. This is another feature that enhances the feeling of the game and promotes the willing suspension of disbelief and role playing.

In a competitive environment like Sell!, where every player has the same goals and opportunities for cooperation are scarce, there is less value added by interacting with other human players. Although, human nature being what it is, we expect to find some players helping others with hints and advice out of their own generosity, there is little that can be generally anticipated in this regard. We hope, in future games, to devise simulated environments where team-play and cooperation can be rewarded with success in the game.

In the next version of the game, players will be occasionally visited by salesmen offering training course for employees, or Little League coaches soliciting donations for team uniforms. These visitors are Non-Player Characters (NPCs) --- robot players who seek to engage players in sometimes frivolous, sometimes meaningful interactions. These exchanges will promote the feeling of unpredictable reality that can make a simulation seem more "real", while at the same time giving the players opportunities to think on their feet. Some of the NPCs will be offering valuable goods and services, others will be peddling dreck. The player must decide, in their role of shopkeeper, what is worthwhile, and what is not.

Other plans call for robot competitors to populate Springfield even when no humans are playing the game. This will level the field in terms of the advantage we have noticed that goes to players who enter the game first and establish themselves before other players enter the simulated environment. These "agents of retail" will undertake differing retail strategies: conservative vs. risk-taking, expansive vs. cost-conscious, and so forth. They will serve as models

for players to copy or avoid, and will form the basis for a case library for competitors that the tutor will retrieve as examples and counter-examples for role-playing.

Teaching Goals and Learning Roles

The game is an intelligent educational simulation but little is ever explicitly taught in the game. Rather, the game does two things:

1. Assigns a well-defined, understandable role to the player which motivates them to learn more about economics and marketing in order to win the game; and
2. Provides resources that allow the player to learn.

Learning takes place in the game as a consequence of:

1. seeing the results of actions in the simulated world.
2. interacting with the "tutor" (and the real and simulated agents that populate the environment).
3. by browsing advice networks (similar to Ask systems), and seeing stories.

As each turn progresses, players learn their role in the environment and see the results of their actions as well as the impact of other players' actions within the constraints of the simulated world. People like to play, and children have always learned about their society and themselves through role-play, be it playing house, or playing store, or playing doctor.

Learning by doing is the oldest trick in the educator's book, and by leveraging off the natural human proclivity to play and role-play, the game helps players learn about the real world by helping them learn a role in a simulated one. And it helps them learn successful strategies (and win!) by helping them learn their roles exceeding well.

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