EBIZ GAME: A SCALABLE ONLINE BUSINESS SIMULATION GAME FOR ENTREPRENEURSHIP TRAINING

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ABSTRACT

This article examines how a scalable web-based business simulation game was evolved and developed; and how it can be used as an exercise in entrepreneurship training and as competitive platform.

The use of simulation offers entrepreneurship educators many instructional opportunities that would be unavailable to students without the use of simulations. The eBizGame simulates the competitive and dynamic business environment and allows students to role-play on an interactive basis as directors of a small business. Through simulation, students can sharpen their business acumen, develop desirable process skills and demonstrate problem solving and thinking skills; and creativity and innovation. This article examines how the game was evolved, developed and used for entrepreneurship training and competitions. XML, N-tier architecture and load-balancing techniques are used to implement this web-based game.

INTRODUCTION

The eBizGame offers a simulation that encompasses many of the factors that occur in day-to-day business operations of a small business. It has been used for training at least six batches of entrepreneurship students since July 1997. It has also been run successfully as a competition for the past 3 years.

At the Award Presentation Ceremony on 24th March 2001 of the competition organized for secondary schools, the Guest-of-Honor, Miss Leong Yop Pooi, Deputy Director, Humanities and Aesthetics Branch, Curriculum Planning and Development Division, Ministry of Education, highlighted to all participating teams that technology was neutral. Unless the key business concepts, principles and processes were understood, applied and integrated into the business operation, the most sophisticated hardware and software would be ineffective. Ultimately, entrepreneurial skills and business acumen were still largely responsible for the long-term success of any business. Her comment emphasizes the need to fully incorporate the simulation into all aspects of the entrepreneurship course.

Business simulation games should not stand alone in classroom use. They are of limited effectiveness if not successfully incorporated into all classroom strategies and evaluation methods. Although winning is important in any games, students should be constantly reminded that the primary objective of playing the simulation game is learning. In fact the loser of the game has more to learn if he draws lessons from the mistakes made in the game. Well-developed simulation games should be included and incorporated into all class discussions and lectures. If not, students may view stand-alone simulation games as time-fillers and as irrelevant materials. Thus students must be given an overview of the topics before playing the simulation game and a debriefing when the game is over.

It took almost a year to complete developing the game and the development process could be divided into two phases. The first phase involved formulating the basic structure of the game and gathering the vast amount of background, technical and financial information needed to enhance the game's realism. A major requirement of the game is that it must sophisticated enough to "expose" the student who is playing the game to prepare him for business situations; and yet not too complicated (or complex) for him to understand and apply the basic management principles. The second phase consisted of developing the game into a form that could be handled by the department server and writing all the necessary software. At the second phase, the various documents to be used in the game were also written.

The prototype game was thoroughly pilot tested by the July 1999 Semester students in order to eliminate any obvious flaws. In conjunction with the launch an internal competition was organized. Only then were the final documents produced and the go-ahead given to run the

game as a school competition during the coming academic year.

HOW THE EBIZGAME WAS EVOLVED

A widely accepted definition of simulation describes it as a pedagogical method of attempting to reflect actual situations through use of games, scenarios, role-playing, socio-drama, and decisions-making experiences (Andes 1983; London 1970). This definition provides us with a broad base from which simulations may be developed and does not limit entrepreneurship educators to the contemporary notion that all simulations are computer based. Ngee Ann Polytechnic started using simulations in entrepreneurship courses in July 1991 when it set up in the campus as a practice outlet a retail shop with a shop space of about 300 sq meters, called The Student Shop. The shop was completely run by 170 students in the Small Business Management course. This was where they got hands-on training on how to start their own business, how to keep inventory, take a loan from a bank, keep accounts and generate profit and loss statement at the end of a semester. They also learnt how to promote and make sales. This experiential approach allows the student to obtain a level of comprehension and skill development in running a small business that is seldom attained through traditional teaching methods.

However, as the number of entrepreneurship students doubled to more than 300, it was found difficult, if not impossible, to roster so many students to run The Student Shop. Thus in July 1994 The Student Shop was dissolved and replaced by mini-stores in the atrium of the Administrative Block. This business format offered greater flexibility to students, as they were no longer limited by space and time. They could open their stores beyond the scheduled tutorial hours as long as space was available and they had no more classes. However, one main set back of these simulations is that students would incur huge monetary losses if their goods were not moving fast as they had only about ten weeks to clear their goods. They were so obsessed with sales that they neglected proper planning and developing effective strategies.

In early 1998 Mr Khoo Chin Hean, Principal of Ngee Ann Polytechnic, floated the idea of developing our own computer-simulated business game for entrepreneurship training as the IT infrastructure in the campus was sufficient to cater to mass participation of any computer simulation games. One main advantage of a computer-simulated business game is that it can simulate a real life situation where students could experience running a business; and yet do not have to worry about incurring personal monetary losses. The timeline of running the business could also be made longer by the simulation so that students can practice long-term planning and strategy formulation.

Thus this led to the development of the eBizGame and in July 1999 the mini-stores operation was dissolved and replaced by the simulation game.

THE SIMULATION GAME OBJECTIVES

Although it was always hoped that the eBizGame would be fun to compete in, it was intended that it should meet several serious and important educational objectives:
1. fostering entrepreneurial spirit in students by providing them the experience of running a business when working as a team for a "company" in a simulated business environment;
2. develop creative and critical thinking skills by providing them the opportunity to plan and formulate winning strategies;
3. hone analytical skills through the analysis and interpretation of financial information and application of business concepts for decision-making; and
4. promote teamwork among students.

In addition to these objectives, the simulation also helps students to (1) strengthen oral and written communication skills, (2) develop strong problem-solving skills, and experience application of business theories and concepts.

The game must also meet the following design objectives:
1. A simple-to-use, easy-to-understand user interface for player and game administrator.
2. Adequate responsiveness (web page loading time) for the game-play front end used by the players and game administrator.
3. A game that is capable of supporting unlimited number of users online concurrently; only limited by the hardware architecture.
4. Adequate flexibility in the database design to accommodate future enhancements.
5. Integration with the department's overall Enterprise Architecture.

The following section lists some of the important business concepts that can be learnt from the simulation which are essential to the entrepreneurship curriculum:

1. Methods of sales forecasting, e.g. exponential smoothing or simple trend analysis
2. Factors influencing sales volume, e.g. promotion and R&D spending
3. Stock and production planning
4. Cash flow and budget planning
5. Difference between profits and cash
6. Market research and competitive analysis
7. Trend analysis for opportunities
8. Breakeven analysis and sales
9. Profit planning and price
10. Economic and management concepts like shape of a cost curve, law of diminishing returns, economies of scale
11. Ratio analysis and benchmarking for monitoring

performance

12. Interrelations of departments—importance of coordination and proper planning

DESCRIPTION OF THE SIMULATION

eBizGame simulates an oligopolistic industry. Three to eight companies compete in a single-product market selling a consumer good. At every period, the participants submit decisions on price, production, promotion, plant investment, R & D, training and development, and market research. The simulation automatically grants repayment or borrowing of loans. Each period represents a quarter. The economic environment of the industry is controlled by a number of parameters including R&D, price and promotion sensitivity factors. Thus the economic environment can be changed every period by the game administrator by adjusting the parameters. At the beginning of every period, each company receives various reports including the cost parameters report that contains values of some cost parameters, e.g. plant purchase price, credit limit and interest rate. Likewise, at the end of each period, each company receives various reports including an industry report on industry benchmarks, market statistics such as production, sales and inventory, and market research data. A summary table of the various reports is shown in Table 1. Students can even use the built-in graphing program to draw charts for some of these market statistics.

Table 1:*Various Reports Generated by the Simulation*

Industry Report	Plant Investment Report
Company Report	Labor Report
Management Report	Marketing and R & D Report
Decision Analysis Report	Inventory Report
Finance Report	Cost Parameters Report
Production Report	

The usual competition consists of two rounds, with each round made up of usually seven periods. It operates on a knock-out basis whereby the winners of the preliminary round will go on to compete in the final (next) round of play, and the winner eventually emerges. In each round, the teams are grouped into different clusters of three to eight teams each. Each cluster plays a game, which is independent from the other games. However, all clusters begin each round with an identical business background. At the end of a round, the performances of participating teams are evaluated on a set of criteria. The winning teams then proceed on to the next round of play. The winning criteria include accumulated profit, sales growth, net profit margin, product attractiveness, return on equity, market share, and plant capacity.

As a learning exercise for students taking the Managing a Small Business module, students only play one round and traditionally the simulation is run immediately after seven weeks of lectures covering all the aspects of starting and running a small business. It is also important to make students go through an administrator's briefing and a trial run before playing the game as certain aspects of game-play might prove too complicated for a first time player.

Before the game starts the role of each team member should be decided and chosen from one of the following:

1. Managing Director—responsible for co-coordinating the decisions of the other team members
2. Sales Director—responsible for sales forecasting, break even analysis and setting the prices
3. Marketing Director—responsible for market research, promotion and R&D for product development
4. Production Director—responsible for production and inventory control
5. Financial Director—responsible for interpreting the accounts and forecasting cash flow
6. Planning Director—responsible for planning plant capacity, training and development, and profit planning

(If less than six members per team are playing, the roles can be combined, e.g. the Financial Director can be responsible for planning.)

Much of the learning from a simulation or game takes place through processes of reflection (Kolb 1991) after the experience rather than during it. Long after the participation is over, learning continues to take place. In this respect it is critically important to help students to process what they have experienced. Thus, at the end of the Final Round, every team has to submit a written report ("Directors' Report") on the lessons learnt from the game. The best directors' report team will then be invited to give a short oral presentation of its report. This is followed with a debriefing by the game administrator. The debriefing helps the students to learn from their experiences by processing those experiences effectively.
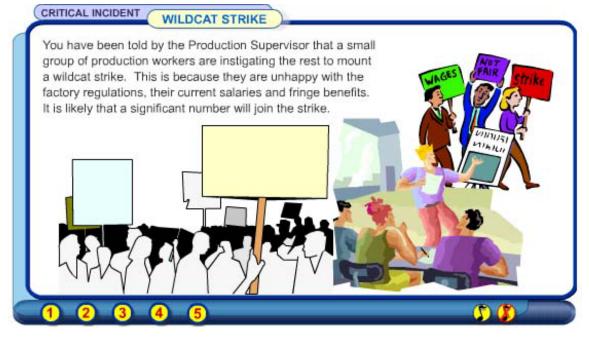
WHAT THE GAME ADMINISTRATOR COULD DO

The game is made extremely flexible to the game administrator. It provides a template for the administrator to change the product description. Its default parameters can easily be changed. Thus the administrator can create one game to simulate one product and another game to simulate another product; and make both games simulate different economic conditions, cost structures and market responses.

The administrator can select which market research data are made available to the students and at what prices.

The game has a template for the administrator to create new qualitative case studies. These case studies present management dilemmas or critical incidents faced by the company. They are created using Flash animation as shown in Figure 1.
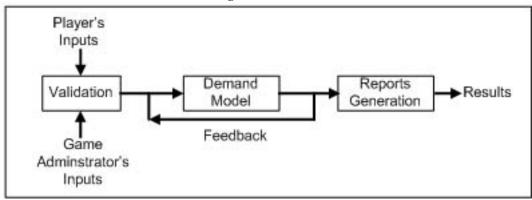
Figure 1. An Example of Critical Incident

WHAT THE PLAYER COULD DO

As a turned-based game, the players make decisions every period. They can be the first or last to make decisions. They can call up data about past performance, financial records, promotion, R&D and plant investment, operating and production costs, or anything else thought necessary. Furthermore, the game has very interactive capabilities. The players can communicate with other players online through the game website. If they need consultation, they can also communicate with the game administrator on a private basis. The game has a Journal for the administrator to update the players about the changes in the economic environment. Students will also be given news to read. The news is divided into two sections: public news and private news. The private news gives specific advice to the players on their current situation. Reports are generated immediately after the closing of each period and students can display most of the market statistics provided using the built-in graphing program.

HOW THE ACTUAL SIMULATION GAME WAS DEVELOPED

We began by researching various business demand models that could be used for the game. It took us six months to build a game model based on our requirements. The game model consists of three components as shown in Figure 2. The inputs (decisions) entered are first validated to see that they are within the limits set by the game administrator and the game model. Other logical constraints are also checked at this point. The validated inputs are then applied to the demand model together with the history. The output of the demand model will be saved as history and feedback to the model later. The reports will then be generated based on the output of the demand model.

Figure 2. The Game Model

THE DEMAND MODEL

The modeling of the demand model is the heart of the game. The designing and developing of this model is primarily an art. Theoretical demand model was used as the baseline in this model. Good design is a necessary but not sufficient condition of a business simulation. Therefore, real business experiences from several experts were incorporated into the model. This makes the model realistic and practical. The algorithm of the demand model is shown below:

1. Calculate productivity of the firm
2. Calculate product quality of the firm
3. Calculate the means of the economic parameters
4. Calculate the exponential smoothed parameters
5. Calculate market demand
6. Calculate firm demand

This demand model was implemented with reference to the "Suggested System for Modeling Demand" by Steven C. Gold and Thomas F. Pray's (1990). There are three types of functional forms in the internal modeling of demand in computerized business simulations (Gold and Pray, 1990): linear, nonlinear, and log-linear. The linear form has the property of variable price elasticity but constraints the marginal impacts of the independent variables to be constant. The nonlinear functions vary widely in form and nature and have properties inconsistent with modern demand theory. Log-linear functions allow marginal impacts to change with the level of the independent variable but not flexible enough to model inflection points. The demand model implemented in the eBizGame includes a number of properties:

1. The use of simple comparison to calculate the productivity of the firm
2. The use of accumulated R&D investment to calculate the product quality
3. The use of harmonic mean to approximate the market price as compared to the conventional mean calculation which overstates the average industry price
4. The use of scaling factors and exponential smoothing to capture inter-temporal effects and allow the designer to control the importance of history on current demand
5. The use of multiplicative functional form, which is stable and possesses variable elasticities.

The following sections highlight some of the algorithms used.

1. CALCULATE PRODUCTIVITY OF THE FIRM

The productivity of the firm depends on the investment in the Training & Development of the workers in the firm. The firm's productivity is calculated using Equation 1.

$$Fp_i = Bp + Vp\left(\frac{TD_i}{TD_{Highest}}\right) \qquad (1)$$

Where:
Fp_i is the firm's productivity
TD_i is the firm's Training & Development
Vp is a variable set by the game administrator
Bp is the baseline productivity set by the game administrator

2. CALCULATE PRODUCT QUALITY OF THE FIRM

Quality of the Product depends on the cumulative R&D investment. When the game is first created, a set of predefined values for the quality levels are created using Equation 2.

$$QualityLevel = R\&D_{MAX} \times (Y \times QualityLevel) \qquad (2)$$

Where:
$R\&D_{MAX}$ = Maximum R&D limit set by the game administrator
Y = designer's specified value (Y>1)

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3. CALCULATE THE MEANS FOR THE ECONOMIC PARAMETERS

Averages for Promotion and R&D are calculated using Equation 4 and 5 to determine the market demand later. As harmonic mean computes the average by weighting low values relatively more than higher values, it is used to calculate the average price as shown in Equation 3.

$$Average\,Price = \frac{n}{\sum_{i=1}^{n}\left(\frac{1}{p_i}\right)} \tag{3}$$

$$Average\,Promotion = \frac{\sum_{i=1}^{n}(Promo_i)}{n} \tag{4}$$

$$Average\,R\&D = \frac{\sum_{i=1}^{n}(R\&D_i)}{n} \tag{5}$$

Where:
n = Total number of firm
p_i = firm's price
$Promo_i$ = firm's Promotion
$R\&D_i$ = firm's R&D

4. CALCULATE THE EXPONENTIAL SMOOTHED PARAMETERS

The demand of the product not only depends on the current decisions but also on the historical decisions. Exponential smoothing is a convenient technique allowing simulation designers to specify the role and importance of history on current demand. The parameters are multiplied by a scaling factor before they are exponentially smoothed as shown in Equations 6, 7 and 8. These scaling factors are designer's specified values. The results from Equations 6, 7 and 8 are applied to Equations 9, 10 and 11 respectively.

$$P = P\left(1 + \frac{X}{100}\right) \tag{6}$$

$$Promo = Promo\left(1 + \frac{Y}{100}\right) \tag{7}$$

$$R\&D = R\&D\left(1 + \frac{Z}{100}\right) \tag{8}$$

$$P = aP_n + (1-a)P_o \qquad ; \text{where } 0 < a < 1 \tag{9}$$
$$Promo = bPromo_n + (1-b)Promo_o \qquad ; \text{where } 0 < b < 1 \tag{10}$$
$$R\&D = c\,R\&D_n + (1-c)\,R\&D_o \qquad ; \text{where } 0 < c < 1 \tag{11}$$

Where:
P = exponentially smoothed price
Promo = exponentially smoothed Promotion
R&D = exponentially smoothed R&D
X = scaling factor of price
Y = scaling factor of promotion
Z = scaling factor of R&D
a = impact of Price over a duration
b = impact of Promotion over a duration
c = impact of R&D over a duration

Where subscript:
"o" indicates a period-old smoothed value
"n" indicates the most current value

5. CALCULATE MARKET DEMAND

The market demand depends on the average price, promotion and R&D of the firms, the number of firms and the disturbance factor. Firstly, the market demand is calculated using Equation 12. Then the result of Equation 12 is applied to Equation 13. Finally, the result in Equation 13 is applied to Equation 14.

$$Q = g_1 P^{-(g_2 + g_3 P)} Promo^{(g_4 - g_5 Promo)} R\&D^{(g_6 - g_7 R\&D)} \tag{12}$$

$$Q = Q(n-1) + Q \tag{13}$$

$$Q = Q(1+D) \tag{14}$$

Where:
Q = Industry demand
P = Average Price in the industry
Promo = Average promotion in the industry
R&D = Average R&D in the industry
n = Number of firms
D = Disturbance factor
g_1 to g_7 are designer's specified values.
g_1 is a scaling factor

6. CALCULATE FIRM DEMAND

There are 3 steps to calculate the firm's demand. The first step is to calculate the firm's total weight using a weighting function. It is a variable elasticity multiplicative function. It determines the magnitude of the value that is used to calculate the market share of the firm as a function of the total market demand.

$$W_i = k_0(P_i + k_1)^{-(k_2 + k_3 P_i)}(Promo_i + k_4)^{(k_5 + k_6 M)}(R\&D_i + k_7)^{(k_8 + k_9 R)}(PQ_i + k_{10})^{(k_{11} + k_{12} TI)}$$

(15)

Where:
W_i = weight of the firm
P_i = exponentially smoothed price of the firm
$Promo_i$ = exponentially smoothed promotion of the firm
$R\&D_i$ = exponentially smoothed R&D of the firm
PQ_i = Product Quality of the firm
k_0 to k_{12} = designer's specified values

The values assigned to the parameters (k_2, k_3, k_5, k_6, k_8, k_9, k_{11}, k_{12}) depend on the designer's specification concerning firm-level elasticity. The purpose of k_1, k_4, k_7 and k_{10} is to prevent the weight from becoming zero. K_0 is a scaling factor and can be arbitrarily assigned a value to ensure that the firm's weights are not too large or too small for computation accuracy. The next step is to calculate the firm's share. The share equation is shown in Equation 16.

$$S_i = \frac{W_i}{\sum_{i=1}^{n} W_i}$$

(16)

Where:
S_i = firm's Share
W_i = weight of the firm

The firm's share will be converted to quantity using the quantity function as shown in Equation 17.

$$q_i = S_i Q$$

(17)

Where:
S_i = firm's Share
Q = Industry demand
q_i = Quantity demand of the firm

Finally the industry demand is recalculated based on the summation of the firm's demand as shown in Equation 18. This is to avoid rounding error that may occur.
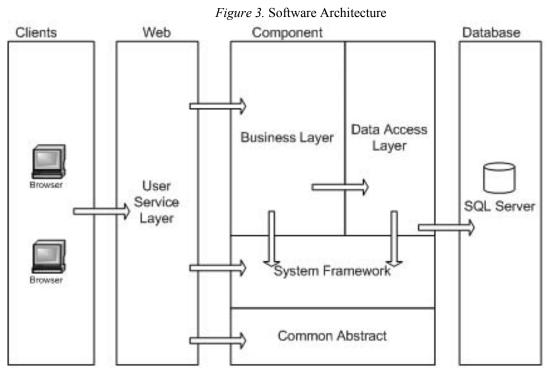
$$Q = \sum_{i=1}^{n} q_i$$

(18)

Where:
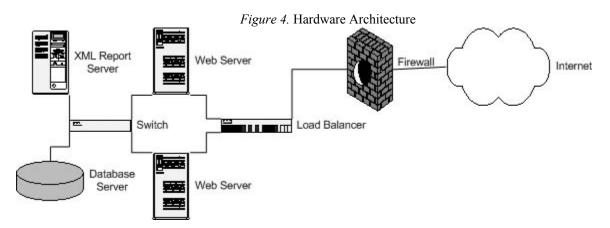Q = Industry demand
q_i = Quantity demand of the firm

ARCHITECTURE

After the prototype of the game model was verified, the game model was built into SQL Server using stored-procedures and functions. Most of the business logic was processed in the database. Next, we began to design the website interface. In order to make this website scalable, most of the processing was done on the client-side (web browser). ActiveX controls, Flash applets, and DOM were used. The graphs were rendered on the client's web browser using an ActiveX control. The reports were rendered on the client's web browser using XML, XSLT and DOM. All the reports generated by the game were saved as XML files when the period was closed. The closing of the period was the most processor intensive task of the game. The decisions of all the players and the settings set by the administrator were applied to the game model in this task. The reports of the period were also generated in this task. All this processing was distributed between the database server and the web application server. The business logic was calculated in the database server; whereas the reports were generated by the web server and saved in a file server. A pool of persistence database connection was created when the game was first loaded in the server. This was to reduce the overhead of having recreating the same connection again and again when the game was playing. As shown in Figure 3, the software architecture of the game is divided into 5 logic layers:

1. User Service Layer: This layer provides access for clients (PC and Pocket PC) to the application. It consists of web pages and web services.
2. Business Layer: This layer provides interfaces to the User Service Layer to handle player's decisions, report browsing, web navigation, news browsing, chatting functionality and administration of the game.
3. Data Access Layer: This layer provides data services to the Business Layer. Connection Pooling was implemented at this layer.
4. System Framework: This layer provides application configuration, exception handling and logging of the game.
5. Common Abstract: This layer provides common structures used in the game.

Figure 3. Software Architecture

The game was hosted on two web servers, which are connected to a load balancer. The reports were stored as XML files in another server. The database was stored in a dedicated database server in the web farm. The hardware architecture is shown in Figure 4.

Figure 4. Hardware Architecture

By adding additional web server we will increase the capacity of the application. The reports of the game are saved as XML files in the XML Report Server. This is to off load the database when the game starts and the players are accessing the reports. By doing so the game is able to handle a larger number of concurrent users. A service agent was built to allow the game administrator to schedule batch jobs (for closing of a period) to run automatically on the server.

A computer-automated stress test was conducted with the use of three computers to determine the maximum load of the game. Seventy-two concurrent users were simulated to play the game. Eight users in a group were simulated to play a game. Each user was simulated to access the game continuously during the stress test and to input random values into the game. This was to provide a more accurate load-testing result. The game was able to handle a maximum of nine concurrent competition clusters during the stress test.

THE COMPETITIONS HELD BETWEEN 1999 AND 2002

Thirty-five teams comprising 179 students taking the Managing a Small Business (MSB) module, took part in the first run of the eBizGame competition, which was held in the July 1999 Semester. The competition was then extended to secondary three students in the subsequent two years. In the Year 2001 competition, twenty-one teams (one team per school) took part; and in the Year 2002 competition, forty-seven teams took part. They played the game from their own schools, as the game was web-based. At the end of the Preliminary Round the best team from each cluster proceeded on to the Final Round, which was held in NgeeAnn Campus. The winners were given attractive prizes.

For the secondary school students, they have to undergo two separate days of entrepreneurship training before playing the game. The training gives them an overview of management principles and concepts and some simple accounting knowledge.

All MSB teams were asked to complete a detailed questionnaire, which was subsequently analyzed by the teaching staff of that module. The responses to Question 10 in the questionnaire show an overall high level of satisfaction (see Table 2). The feedback received from the participating secondary schools had been a great success, and it was clear that the competition should be run again.

Table 2: *Responses to Question 10 of the Questionnaire, 2002 January Semester*

10. Please indicate whether the game helps you in:			
	Agree(%)	Unsure(%)	Disagree(%)
(a) Understanding concepts	96	2	2
(b) Practical applications of concepts	92	6	2
(c) Developing friendly relations/rapport	90	5	5

The game is still run regularly within NgeeAnn as part of hands-on training for students taking the Managing a Small Business module, and is also run as an open competition for secondary schools. The co-authors (who were primarily responsible for the computer modeling) have not been allowed to rest on their laurels. With the support from Teaching & Learning Centre (TLC) and Ngee Ann Industry Technology Exchange Centre (NITEC) they will approach a software company to get it converted into a Chinese version and launch it in China. China is chosen because the cultural differences between Singapore and China are not great. Furthermore China is keen to try out new methods of teaching entrepreneurship—based on feedback from recent visits to China by NgeeAnn staff.

CONCLUSION

In this paper we described how the eBizGame, a scalable web-based simulation game, offers a solution to the problem of helping students in the Managing a Small Business module attain the necessary competencies both based on and building upon a curriculum in which simulation plays a central role. The eBizGame has built-in features (parameters) whereby the administrator can vary the complexity of the game so that it could fit in with any entrepreneurship curriculum requirements ranging from Secondary School to Polytechnic levels. The game is web-based so it is accessible to participants anywhere and this means even students from different places (even countries) can come together as a team to play it. This opens a new dimension to cross-cultural behavioral learning. The individual learner's experience is an experience of discovery and of learning about the reality being modeled by exploring it. Its instructional value lies in the transferability and applicability of the choices made to other life activities and their behavioral choices therein. This can be called the validity of the simulation or game (Lederman, 1994).

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