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AN INVESTIGATION OF THE ENVIRONMENTAL AWARENESS ATTAINED IN A SIMPLE BUSINESS SIMULATION GAME

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ABSTRACT

Past research examining participant adaptability to game parameters in computerized business simulation games has examined the degree to which game participants understand the environment into which they are placed. Results suggest that participants only moderately understand their environments. It is felt that the complexity of the simulations used in these studies contributed to the lack of significant findings. This study uses a very simple simulation game in which the game administrator can only manipulate two game parameters. Decision responses were gathered from 331 single player competitive companies assigned to fifty-nine six team industries for a nine period competition. As with past studies, only moderate learning of the simple environment was found.

INTRODUCTION

Good business managers make good decisions. To make good decisions business managers must understand the marketplace environment in which they are competing. If business simulation games are to provide good learning opportunities for business students, students must be able to understand the environment created for the simulation competition and develop strategies that adapt to that environment. This would serve as clear evidence of learning in the simulation environment (Gentry, Stoltman & Mehlhoff 1992; Hatton, Hatton & Mecord 1992; Washbush & Gosenpud 1994; Washbush & Gosenpud 1995; Wolfe & Roberts 1992).

This study adds to an ongoing stream of research pursuing the concept of simulation participation validity predicated on the extent to which participants understand and respond to the simulation environment in which they are placed. Game administrators assume that active participation in the simulation provides participants with the opportunity to learn from their experiences and improve their decision-making skills.

Traditionally, game performance outcomes, such as earnings per share or return on investment, are used as measures of game performance success and learning. When a participant outperforms a competitor, it is assumed that the winner has better understood the simulation environment and has translated that learning into better decisions. Rather than simply measuring performance outcomes, asking participants to articulate their understanding of the simulation environment is another way to measure learning.

PAST RESEARCH

Learning theory (Schiffman & Kanuk 1987) would suggest that underlying the behavioral decisions made by a simulation participant is a learning process that leads to the determination of what types of decisions work (e.g., low price in a price sensitive market). Several studies have examined participant decision-making response to artificially manipulated game parameters (Faria & Dickinson 1990; Faria, Whiteley & Dickinson 1990; Whiteley, Faria & Dickinson 1990).

In each of these three studies, simulation participants were randomly assigned to "push" responsive or "pull" responsive marketplaces. Push and pull strategies are well documented in the marketing literature. Push strategies focus on channel middlemen while pull strategies focus on the household consumer. The results reported in these studies suggested that the participants' decisions only moderately reflected the importance weightings of the game parameters which were manipulated to create the push and pull environments.

A study undertaken by Dickinson and Faria (1994) utilized an administrator created company. In this study, an artificial competitor company was created, and inserted into each competitive industry, using a randomly generated set of decisions. The decisions of the administrator created company were controlled to be within the upper and lower limits of the real competitors in each industry. The purpose of the study was to determine if the real competitors, developing strategies based on the what they learned during the competition, could defeat an artificial competitor utilizing a randomly generated strategy. Overwhelmingly, the real companies outperformed the random strategy companies.

Two previous studies examined the impact of an artificial industry leader (Wellington, Dickinson & Faria 1991; Wellington & Faria 1997). The decisions of the artificially created industry leader were designed to be perfectly in tune with the industry environment. Student participants could learn from the industry leader and, accordingly, better adapt their decisions to the manipulated environment. Only moderate decision-making adaptation to the environment was reported.

While a number of studies have focused on the behavioral side of decision-making, research examining the cognitive decision-making process is light (Whiteley, Dickinson & Faria 1992; Wellington, Faria, Whiteley & Nulsen 1995; Wellington, Faria & Whiteley 1998). These studies reported limited cognitive understanding of the simulation environment and limited correct behavioral response to the manipulated simulation environment. Further, even in cases where participants understood their environment (cognitive learning) they often made incorrect decisions (behavioral learning).

PURPOSE AND METHODOLOGY

The results from past research suggest that game participants have been only moderately successful at understanding and adapting to their simulation environments. However, past research studies have utilized relatively complex simulation games. The present study utilizes a very simple marketing simulation. In addition, the participants have a good decision support system in the simulation that allows them to identify and track environmental variables rather easily.

The simulation used for this study is *PAINTCO V* (Galloway, Evans, Berman & Wellington 1997). The game administrator is able to manipulate only two environmental variables in the competition: level of demand and raw material cost. Participants operate companies that manufacture paint for the retail and organizational markets. Only five marketing decisions are made each period: product quality, distribution, advertising, personal selling, and price.

The subjects for this study were 331 students in two sections of a Principles of Marketing course. The simulation competition amounted to 20 percent of the course grade. The 331 participants were divided into 59 industries of six teams each. Each participant operated as a single person company in the competition. The competition covered nine decision periods comprised of one trial period and eight real periods. During each decision period, participants submitted their decisions which included an estimate of demand level and the raw materials index - the two manipulated environmental variables.

HYPOTHESES

The general hypothesis for this study, as with previous studies in this series, is that if simulation games are to be a meaningful learning tool, participants must exhibit some learning from the simulation experience. In this case, the learning measure used was the participants' ability to track and correctly forecast the demand level and raw material index in the *PAINTCO V* simulation. As learning occurs during the play of the simulation, the participants' accuracy in forecasting these environmental variables should improve. As well, top performing teams should exhibit a greater awareness of the actual game parameters than lower performance competitors. The specific hypotheses formulated for testing were:

H1: The variance between the actual and estimated raw material index will decrease from competition Period 1 through Period 8.

H2: The variance between the actual and estimated seasonality in the demand index will decrease from competition Period 1 through Period 8.

H3: The variance between the actual and estimated raw material index will be smaller for top ranked competitors (first or second in their industry) than for medium ranked (third or fourth in their industry) and lower ranked competitors (fifth or sixth in their industry).

H4: The variance between actual and estimated seasonality in the demand index will be smaller for top ranked competitors (first or second in their industry) than for medium ranked (third or fourth in their industry) and lower ranked competitors (fifth or sixth in their industry).

Hypotheses H1 and H2 were tested using SPSS Reliability Analysis to compare the change in variance between the actual and forecasted game parameters throughout the competition. Hypotheses H3 and H4 were tested by comparing the average variances between the top performing companies (first or second place) on the two manipulated game parameters and the medium ranked (third or fourth place) and lower ranked simulation competitors (fifth and sixth place).

RESULTS

The actual values of the seasonality and raw material indices are reported in Table 1 along with the mean estimates made by the top, medium and low performers. The results of the reliability analyses for H1 and H2 are presented in Tables 2 and 3. The results of the MANOVA analysis for H3 and H4 are reported in Tables 4 and 5.

The reliability analysis supports the partial acceptance of H1. The average variance of the estimates of the raw material index declined from Period 1 through to the middle of the competition. However, by the end of the competition, the variance had increased. An ANOVA analysis of the repeated measures of this index indicated that the change in value between measures was significant. This supports H1 but only partially because the expectation was that the absolute value of the difference would continue to decline throughout the competition.

With respect to H2, the pattern that emerged was the opposite of what was hypothesized. The mean of the absolute value of the variance between the actual and expected seasonality index increased from period to period. The changes were significantly different but they were in the wrong direction. As such H2 is rejected.

The MANOVA analysis of H3 indicates that the better performing teams understood the raw material index better than the poorer performing teams over time. At the outset the mean absolute variance of the raw material index was the same for both groups. However, as the simulation progressed, the top performers had a smaller variance than the poorer performers. Overall the MANOVA results were significantly different indicating the top performing teams were able to predict the raw material index better than the poorer performers. As such, H3 is accepted.

With respect to the seasonality index, H4 is also supported as shown by the significant MANOVA results. The analysis of variance results of the individual periods indicate two significant differences in the middle and at the end of the competition. In both instances the top performers' predictions of the seasonality index were superior to the medium and low performers.

DISCUSSION AND CONCLUSIONS

As has been the case in past studies, the results from this study are mixed. The acceptance of H1, H3 and H4 indicates that participants were able to perceive changes in the raw material index over time and that top performers were better able to identify the raw material index and the seasonality of demand than were poorer performers. As such, there is some indication that participants were able to discern an uncontrollable variable in their environment. However, even in this very simple simulation and with a decision support system to help them, participants did not become more accurate in their forecasts of seasonality over the course of the competition. While the participants were able to determine that changes were occurring, they were not always able to determine the scoop of those changes.

The results from this research are very similar to the results reported in earlier studies. Once again, a group of introductory marketing students could not fully understand the nature of their simulation environment. The participants were able to perceive that their simulation environments were changing but they could not always identify the true nature of the changes.

The fact that participants did not fully understand their marketplace environment, even in a very simple simulation and with a decision support system to help them, is surprising and disturbing. If simulation participants cannot recognize the true nature of their business environments, even in very simple settings, one must ask what is being learned and how are decisions being made?

It is significant to note that the participants were not oblivious to their environments, they did note changes, but they were unable to accurately identify them. The study findings indicate that top performers had a better understanding of their environment than weaker performers - this would be expected. Regardless, it is also true that top performers did not have a "true" understanding of the environment in which they were operating.

The first conclusion that can be drawn from this research is that top performers adapt faster and more appropriately to their simulation marketplace environment than poorer performers. This is not a particularly surprising finding. This finding suggests, as has previous research that a better understanding of the game environment will lead to superior performance and, secondly, one can rule out "luck" as a determining factor in top performance. Top performance is the result of better understanding.

A second conclusion from this study is that participants do not truly understand the actual nature of their simulation environments. This is a very uncomfortable finding for simulation game users.

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TABLE 1

ACTUAL RAW MATERIAL AND SEASONALITY INDICES AND ESTIMATED RAW MATERIAL AND SEASONALITY INDICES BY PERFORMANCE GROUP

Period 1 - Raw Material index

Estimated Values	Mean	Standard Deviation	N
Top Ranked	1.093	.602	82
Med Ranked	1.068	.519	68
Low Ranked	1.288	1.005	34
Actual Value	1.500		

Period 3 - Raw Material index

Estimated Values	Mean	Standard Deviation	N
Top Ranked	1.060	.354	82
Med Ranked	1.096	.305	68
Low Ranked	1.212	.806	34
Actual Value	1.300		

Period 6 - Raw Material index

Estimated Values	Mean	Standard Deviation	N
Top Ranked	1.035	.300	82
Med Ranked	1.106	.396	68
Low Ranked	1.174	.673	34
Actual Value	0.900		

Period 8 - Raw Material index

Estimated Values	Mean	Standard Deviation	N
Top Ranked	0.984	.270	82
Med Ranked	1.009	.300	68
Low Ranked	1.206	.841	34
Actual Value	0.700		

TABLE 1 (Continued)

Period 1 - Seasonality Index

Estimated Values	Mean	Standard Deviation	N
Top Ranked	23.756	2.553	86
Med Ranked	24.235	2.623	81
Low Ranked	22.938	2.470	48
Actual Value	22.000		

Period 3 - Seasonality Index

Estimated Values	Mean	Standard Deviation	N
Top Ranked	27.628	1.511	86
Med Ranked	26.975	1.533	81
Low Ranked	26.938	2.067	48
Actual Value	30.000		

Period 6 - Seasonality Index

Estimated Values	Mean	Standard Deviation	N
Top Ranked	22.453	2.380	86
Med Ranked	23.012	2.658	81
Low Ranked	23.792	3.383	48
Actual Value	26.000		

Period 8 - Seasonality Index

Estimated Values	Mean	Standard Deviation	N
Top Ranked	27.023	1.841	86
Med Ranked	26.309	2.183	81
Low Ranked	26.271	2.421	48
Actual Value	34.000		

TABLE 2

RELIABILITY ANALYSIS FOR H1

MEAN ABSOLUTE VALUE OF THE VARIANCE OF RAW MATERIAL INDEX

	MEAN	STANDARD DEVIATION	N
PERIOD 1	.5750	.5108	184
PERIOD 3	.3620	.3432	184
PERIOD 6	.2387	.3867	184
PERIOD 8	.3734	.4144	184

Analysis of Variance Results

Source of Variation	Sum of Squares	DF	Mean Square	F
Between People	91.16	183	.50	.000*
Within People	46.59	552	.08	
Between Measures	9.66	3		
Residual	36.93	549	.07	
Total	137.75	735	.19	
Grand Mean	.3923			

* significant at < .05

TABLE 3

RELIABILITY ANALYSIS OF H2

MEAN ABSOLUTE VALUE OF THE VARIANCE OF THE SEASONALITY INDEX

	MEAN	STANDARD DEVIATION	N
PERIOD 1	2.5535	1.8101	215
PERIOD 3	2.7814	1.8173	215
PERIOD 5	3.6512	1.8806	215
PERIOD 7	7.4140	2.1314	215

Analysis of Variance Results

Source of Variation	Sum of Squares	DF	Mean Square	F
Between People	641.40	214	2.99	.000*
Within People	5788.00	645	8.97	
Between Measures	3292.54	3		
Residual	2495.46	642	3.89	
Total	6429.40	859	7.48	
Grand Mean	4.1000			

* significant at < .05

TABLE 4

MEAN COMPARISONS AND ANALYSIS OF VARIANCE RESULTS BY PERIOD
FOR RAW MATERIAL INDEX AND SEASONALITY INDEX BY PERFORMANCE GROUP

Absolute Value of the Variance of the Raw Material Index

Period 1 - Raw Material index

	Mean	Standard Deviation	N	F-Value	Sig.
Top Ranked	.568	.451	82	.37	.690
Med Ranked	.550	.390	68		
Low Ranked	.641	.795	34		

Period 3 - Raw Material index

	Mean	Standard Deviation	N	F-Value	Sig.
Top Ranked	.362	.226	82	1.82	.166
Med Ranked	.316	.184	68		
Low Ranked	.453	.668	34		

Period 6 - Raw Material index

	Mean	Standard Deviation	N	F-Value	Sig.
Top Ranked	.204	.258	82	1.51	.224
Med Ranked	.303	.326	68		
Low Ranked	.303	.660	34		

Period 8 - Raw Material index

	Mean	Standard Deviation	N	F-Value	Sig.
Top Ranked	.318	.228	82	2.50	.085
Med Ranked	.374	.213	68		
Low Ranked	.506	.841	34		

TABLE 4 (Continued)

Absolute Value of the Variance of the Raw Seasonality Index

Period 1 - Seasonality Index

	Mean	Standard Deviation	N	F-Value	Sig.
Top Ranked	2.547	1.707	86	2.92	.056
Med Ranked	2.852	1.924	81		
Low Ranked	2.062	1.630	48		

Period 3 - Seasonality Index

	Mean	Standard Deviation	N	F-Value	Sig.
Top Ranked	2.372	1.511	86	3.76	.025*
Med Ranked	3.025	1.936	81		
Low Ranked	3.104	2.003	48		

Period 6 - Seasonality Index

	Mean	Standard Deviation	N	F-Value	Sig.
Top Ranked	3.919	1.689	86	1.67	.191
Med Ranked	3.556	1.817	81		
Low Ranked	3.333	2.253	48		

Period 8 – Seasonality Index

	Mean	Standard Deviation	N	F-Value	Sig.
Top Ranked	6.977	1.971	86	3.47	.048*
Med Ranked	7.691	2.183	81		
Low Ranked	7.729	2.421	48		

* significant at < .05

TABLE 5

MULTIPLE ANALYSIS OF VARIANCE RESULTS FOR H3 AND H4

	H3 RAW MATERIAL INDEX	H4 SEASONALITY INDEX
MANOVA RESULTS		
Pillai's Value	.09536	.07457
Degrees of Freedom	8	8
Approximate F	2.24059	2.01864
Significance	.024*	.041*

* significant at < .05