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SIMULATION PERFORMANCE AND FORECAST ACCURACY—IS THAT ALL?

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ABSTRACT

This study evaluated the proposition that there is a correlation between forecasting accuracy and total enterprise simulation performance. Using Mean Absolute Deviation (MAD) over the periods of play as a measure of forecasting accuracy (predicting unit sales), three significant correlations were found for the five course sections studied. The study found, therefore, that there is a general correlation between forecasting accuracy over the periods of play and simulation standing. Additionally examined were simulation performance compared to a pre-play knowledge-based examination and an applied knowledge final course examination. Not surprisingly, no relationships were found for these latter evaluations. The paper contends that finding a correlation between forecasting accuracy and simulation performance is to be expected and of limited use in assessing what can and should be gained from simulation participation.

BACKGROUND

One of the more common research topics in the use of business simulations has been an effort to determine the individual and group factors that correlate with simulation performance. While there are many factors that have been identified, there is no clear set of findings that consistently predict how participants will perform. Gosenpud and Meising (1983) found that gpa, major, teammate prior acquaintance, affection for teammates, the extent of working together, formalized decision-making, degree of organization, and desire to play were positively related to performance. Gosenpud et al. (1984) found that forecasting accuracy, formal planning, strategic stability, having strategies oriented to price, strategic clarity, and group cohesion were positively related to performance. Gosenpud et al. (1985) identified positive relationships to group cohesion and the personality factors of self-esteem, need for achievement, and internal locus-of-control. Gosenpud (1987), reviewed research on the extent to which academic ability, major, personality, motivation, team cohesion and organizational formality predicted simulation performance and concluded that performance varies with combinations of variables and that some relationships are conditional. Wellington and Faria (1990) found that committee-decision format groups outperformed regional-decision format groups and reported more learning benefits. Gosenpud and Washbush (1991) identified choosing teammates carefully, grade point average and major. Wellington and Faria (1992) found a strong relationship between beginning team cohesion and performance expectations and final game performance. Patz (1990,1992, and 1999) has argued that teams possessing intuiting and thinking strengths establish and sustain superior performances. Anderson and Lawton (2002) found that the application of previously-learned marketing concepts was positively associated with simulation performance. Recent research has done little to clarify the clutter documented by Burns et al. (1990), however, the power of attraction of the search, despite years of inconclusive research, is reflected in Cannon and Burns (1999) argument for determining underlying competencies that can be assessed by simulation performance.

For purposes of the research reported here, of singular importance is the research of Teach (1992) who found consistent relationships between forecasting accuracy (using forecasts of market share and product sales and forecasts of cash flow and profits) and profit performance of simulation teams. This finding should not be surprising since the ability to predict what the firm can and will do in the marketplace makes business decision making easier and, from a pro forma perspective, more accurate. One would expect that, over time, business organizations that forecast well, improve the likelihood of success. Motivated by this research, Washbush and Gosen (2002) examined the relationship between cumulative forecasting error, measured by Mean Absolute Deviation, and simulation performance. Results found were inconclusive, however, they provided the motivation to continue this line of investigation.

METHOD

This study was conducted during the fall and spring semesters of the 2001-2002 academic year using five sections (two in the fall and three in the spring) of the required undergraduate BBA capstone administrative policy course at the University of Wisconsin-Whitewater. Students are assigned to sections of this course on a non-random manner. The simulation used was MICROMATIC (Scott, et al., 1992). The research hypotheses, stated in null form, were:

H1 Simulation performance and forecasting accuracy do not co-vary.

H2 Simulation performance does not vary with pre-play knowledge of the simulation.

H3 Simulation performance does not vary with post-play applied knowledge of strategic concepts and actions.

Hypothesis 1 was motivated as described above. Hypotheses 2 and 3 were suggested, in a roundabout way, by previous research into simulation performance and learning (Washbush and Gosen, 2001, 2002).

Students were self-selected into groups of three or four for purposes of simulation play. Simulation play was a primary focus during approximately the last 1/2 of each course. Other aspects of the course included strategic management concepts, case analyses and an overview and introduction to the simulation. Simulation play began with a practice decision round. In addition to play, students had to write and submit brief periodic performance analysis reports and a final, overall performance assessment. The grading system included pre-play knowledge of MICROMATIC, simulation standing, simulation reports, and peer evaluations. The final exam reflected both strategic management concepts and issues relating to decision making in the simulation. During both semesters the courses were essentially identical except for minor changes in the weights of various components of the courses in final grade determination

Simulation performance was measured using the normalized scoring routine that is a component of the simulation software. The factors used to determine simulation performance within the game's scoring routine were total profits (40%), return on sales (30%), and return on assets (30%). Forecast accuracy was determined by requiring each group to prepare and turn in a forecast for sales in each market area for each decision round. Total demand for each period was determined by summing actual sales and lost sales for each area. Forecast error for each round of play was calculated by subtracting forecast sales from actual demand and converting to the absolute value. For all periods of play, the mean absolute deviation (MAD) was calculated for each group by summing the absolute errors for each period of play and dividing that total by the number of periods of play. A smaller MAD indicated greater forecast accuracy.

Data were analyzed using linear regression. For Hypothesis 1, simulation performance, a simple linear regression was performed using forecast accuracy (MAD) as the independent variable. Similarly, for Hypothesis 2, student performance on a mid-term examination (given before the start of play and testing knowledge of MICROMATIC) was the independent variable. Finally, for Hypothesis 3, final examination performance served as the independent variable. Correlations were also calculated for all variable pairs.

RESULTS

Table 1 shows results of regression and correlation analyses for the five sections. One regression indicated a significant relationship between MAD and performance ($p = .0318$). Four of the five correlations were negative, and three were strongly so. This would be expected because lower MAD would indicate more accurate forecasting and, if forecasting effectiveness is related to better performance, the correlation should be negative. Three correlations were statistically significant beyond the 0.01 level. On balance, Null Hypothesis 1 was not confirmed.

Table 1
Regression and Correlation
MAD vs Performance

Academic Term & Section	# Students	# Groups	Play Periods	MAD *Beta*	Slope Sig.	Adj R^2	Correl.	Corr. Sig.
Fall 2001, Sect 1	31	9	14	-0.0487	0.0318	0.4178	-0.7004	<0.01
Fall 2001, Sect 2	26	8	14	-0.0052	NS	-0.1645	-0.0428	NS
Spr. 2002, Sect 3	37	8	16	0.0040	NS	-0.1399	0.1541	NS
Spr. 2002, Sect 4	33	8	16	-0.0157	NS	0.3867	-0.6887	<0.01
Spr. 2002, Sect 5	26	7	17	-0.0277	NS	0.2760	-0.6298	<0.01

Table 2 shows the results of regression analyses and correlations comparing student scores on the pre-play MICROMATIC test to simulation standing. Table 3 shows similarly calculated analyses comparing student scores on the final exam to simulation standing. Because the researcher used these as knowledge measures, he analogized the test scores to learning scores developed in previous research (as noted above). In general, there was no systematic and consistent correlation between measures of knowledge and simulation performance, and Null Hypotheses 2 and 3 were accepted. While these analyses lack depth and rigor, they are consistent with prior findings (Washbush and Gosen, 2001, 2002). There is no compelling evidence of any knowledge/learning-performance relationship.

Table 2
Regression and Correlation
Micromatic Test vs Performance

Academic Term & Section	# Students	Micromatic Test *Beta*	Slope Sig.	Adj R^2	Correl.	Corr. Sig.
Fall 2001, Sect 1	31	1.1206	NS	-0.0073	0.1623	NS
Fall 2001, Sect 2	26	2.1831	0.0342	0.1385	0.4159	<0.05
Spr. 2002, Sect 3	37	0.8210	NS	0.0669	0.3046	NS
Spr. 2002, Sect 4	33	0.5360	NS	-0.0256	0.0801	NS
Spr. 2002, Sect 5	26	0.6559	NS	-0.0103	0.1735	NS

Table 3
Regression and Correlation
Final Exam vs Performance

Academic Term & Section	# Students	Final Exam *Beta*	Slope Sig.	Adj R^2	Correl.	Corr. Sig.
Fall 2001, Sect 1	31	1.1866	NS	0.0766	0.3276	NS
Fall 2001, Sect 2	26	2.2253	NS	0.0989	0.3673	NS
Spr. 2002, Sect 3	37	0.8962	0.0418	0.0876	0.3361	<0.05
Spr. 2002, Sect 4	33	0.0130	NS	-0.0323	0.0020	NS
Spr. 2002, Sect 5	26	-0.4816	NS	-0.0294	0.1084	NS

DISCUSSION

The major findings in this study are consistent with Teach's (1992) findings that forecasting accuracy correlates with simulation performance. This is scarcely surprising since, from a *pro forma* perspective, reasonably accurate forecasts must lead to reasonably accurate projections of revenues, expenses and cash flows. Additionally, it is reasonable to expect a learning curve effect over time (seen here to a degree) encouraging better forecasting. However, there are legitimate questions that can be raised about Teach's assertion that forecasting is a critical measure of managerial competence and therefore uniquely important to evaluation of participants in simulations. Such an assertion shortchanges both managers and students of management. Clearly, managing requires far more than developing some facility with forecasting. Moreover, there is far more that students can learn about management (and themselves) from the simulation. Like it or not, real strategic managers are held to rather rigorous profit performance standards. This may not be fair or even completely logical, but it is reality. For the student, the simulation provides an opportunity to do a number of things that are generally missed in most of the non-simulation experiences they encounter in they typical business course of study. Among these are:

- Taking responsibility for the OUTCOMES of decisions
- Problem finding
- Identification of key strategic concerns through analysis of performance data
- Testing aptitude for and desire to manage
- Assessing willingness to take risks
- Assessing personal performance under risk-stress conditions
- Developing other abilities relevant to an organizational career

Washbush and Gosen (2002) have argued that simulations are consistent with and complement the learning environment of the traditional policy course. There continues to be a need to explore that that issue. There exist, no doubt, a plethora of issues, outcomes, behaviors and potentials. Looking for a magic bullet for assessment is tempting, but the richness of the simulation-learning environment demands more.

It is also important to note that Wolfe and Roge' (1997) have identified a number of important elements of learning common to most popular total enterprise simulations. These include strategy, environmental analysis, forecasting, market development and penetration, cost and differentiation strategies, and performance measures. Assessing learning in all such measures would seem to be relevant information for students who participate in the simulation experience. However, their paper also implies that another important aspect of the simulation environment is instructor intent. Instructors using simulations should clearly determine what they want the simulation to do. Those intentions may be unique to the individual instructor, but they are nonetheless valid to that specific situation. It is therefore important for the instructor to not only be aware of the learning potential of a given simulation, but that person should consciously determine how that simulation best complements the course and its objectives. Assessment of student learning should reflect all of these realities.

As researchers continue to examine learning potential and learning methods in the simulation, the likelihood is that a complex array of findings will emerge, as it has to an extent already. Such results should not be viewed as problems to be transcended. Rather they should be seen as reflective of the complexity inherent in organizations and organizational studies. The user of a simulation should employ it with wide-open eyes, armed with the best information available about the simulation to be used and its potential. No "one size fits all" approach is desirable or even possible. In the end, instructors must do what they have always done, use best efforts to design and assess the learning environment. Efforts aimed at helping instructors exercise those unavoidable responsibilities should continue, but with acceptance and appreciation of the clutter which will inevitably result.

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