Developments in Business Simulation & Experiential Exercises, Volume 16, 1989

PREDICTING INDIVIDUAL DECISION MAKING PERFORMANCE IN A BUSINESS SIMULATION

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ABSTRACT

The performance of individual students was examined to determine if predictions can be made as to how they will perform in a simulation and whether the simulation actually teaches what we intend. The research involved having 147 students individually make two quarters of decisions at an advanced stage of the simulation after having participated in a full semester as a member of a simulation team. Results showed that previous GPA, level of participation. gender. previous course grades and grades in Principles of Management were all significant predictors of success.

INTRODUCTION

Previous research results in the simulation field have been divided in establishing relationships between performance and traits of the student, Gosenpud (1987) stated that "It is impossible to legitimately draw conclusions when only five or six a methodologically diverse studies have focused on the relationship between performance (in a simulation) and a given predictor." The research reported here is an effort to use a divergent methodology in order to contribute to the field. The distinction between the present study and previous efforts is that, although students participated in a simulation as members of teams during the regular semester and received grades (25% of the final grade) for their team performance, the measure of performance in this study was the standing of the students in a final examination in which they each were the individual decision makers in the simulation.

The authors have team-taught the capstone course in business policy for a number of years. using a combination of ease study and computerized simulation (with a heavy emphasis upon the latter). We share the concerns so often expressed in meetings of ABSEL regarding the relationship between what we do and what happens to our students. Can we predict which students will do well in the simulation? Does simulation actually teach what we intend? Is there a payoff for the graduate down the line?

Stated in terms of research, these may be identified as the question of predictability of performance in the simulation, the question of internal validity, and the question of external validity. This study has focused upon the question of predictability, with some interest in the question of internal validity,

Past Studies

Gosenpud (1987) reviewed the research on predicting performance in simulation gaming. He identified as factors likely to affect simulation performance the following: academic ability, personality. interests and background. motivation, cohesiveness, and formality (of the organization).

He found five studies which purported to support the conclusion that academic ability does predict successful performance in simulations, but he also identified five studies which disagree with that conclusion.

Research by Hornaday and Wheatley (1986) and Gosenpud and Miessing (1983) found that accounting majors scored higher in the simulation, while Niehbor and Norris (1980) found that students with quantitative skills performed better. On the other hand, other research found that these relationships were not established (Wolfe, 1978; Gosenpud, Milton and Larson. 1985; Vance and Gray. 1967).

Research results on the other factors identified by Gosenpud were also inconclusive. It suggested that it is impossible to draw conclusions due to the small number of methodologically diverse studies. Similarly, he found a number of difficulties which confront the researcher when attempts to study how multiple factors may work in combination to influence performance.

Present Study

The present study seeks to test previous hypotheses by examining individual performance of students toward the end of a semester in which they participated as members of large teams in a simulation. Therefore, the re-search examined not only academic ability, background and interest, but also *sought* to determine whether participation in the simulation contributed to the ability to perform well on an examination which pitted every student against others for two quarters of decision making. The research sought to discover what factors which students brought to the course may have influenced their ability t perform well, and to discover what they may have leaned during the simulation which could help them perform well.

Hornaday and Wheatleys study (1986) was definitively helpful in guiding the present research. They tested four null hypotheses relating GPA, gender, academic major, and personality orientation to performance in the simulation. Analyses of vat lance revealed that while GPA did not predict success, females out performed males, teams with at least one accounting major out performed those without, and teams with one member characterized by marginality (a non-marginal personality is defined as one who identifies with one's own group to the exclusion of others) out performed those lacking a marginal member. Hornaday and Wheatley had previously determined that two-person teams were optimal for student learning.

METHODOLOGY

During the semester in which data were collected *for* this paper, I47 students WE are enrolled in three sections of the capstone course in business policy in a state college. Two day sect ions with a total enrollment of 110 students were included in one industry

Table I

INDUSTRY RATIO AVERAGES (QUARTER 12)

INDUSTRY #	CURRENT	QUICK	DEBT	TIMES INT EARNED	INV T/O	FIXED ASSET T/O	TOTAL ASSET T/O	PROFIT MARGIN	RET ON TOTAL ASSET	RET ON TOTAL ASSET	RET ON NET WORTH	MFG COST PER UNIT SOLD	S&A EXP PER UNIT SOLD
1	8.43	7.51	0.46	4.17	11.00	0.55	0.29	0.16	0.048	0.048	0.042	27.18	5.12
2	9.71	0.52	0.44	5.64	8.86	0.56	0.30	0.22	0.065	0.065	0.057	25.50	4.84
3	18.15	16.45	0.44	5.19	33.97	0.54	0.28	0.21	0.061	0.061	0.054	25.94	5.14
4	18.06	15.57	0.44	5.41	19.13	0.51	0.29	0.20	0.062	0.062	0.056	26.24	4.36
5	13.85	11.90	0.47	4.73	15.15	0.54	0.28	0.20	0.058	0.058	0.052	25.56	5.09
6	11.49	10.14	0.45	5.21	42.75	0.56	0.29	0.22	0.064	0.064	0.051	25.31	4.79
7	8.14	7.04	0.45	6.27	10.12	0.57	0.30	0.24	0.072	0.072	0.065	25.51	4.41
8	7.48	*6.67*	0.46	3.54	9.61	0.52	0.28	0.02	0.039	0.039	0.025	26.39	5.39
9	9.03	7.98	0.45	4.22	15.19	0.54	0.29	0.16	0.051	0.051	0.045	27.51	4.90
10	10.46	8.75	0.46	4.59	20.09	0.54	0.29	0.19	0.055	0.055	0.049	*26.36*	5.22
Average	11.54	9.25	0.45	4.90	18.59	0.55	0.29	0.18	0.058	0.058	0.050	26.15	4.93
Maximum	18.75	16.45	0.47	6.27	42.75	0.57	0.30	.24	0.072	0.072	0.065	27.51	5.39
Minimum	7.48	0.52	0.44	3.54	8.86	0.52	0.28	0.02	0.039	0.039	0.025	25.31	4.36

with nine teams and one night section with 37 students made up the other industry with four teams. The teams of nine to thirteen students were formed by the instructors and, where possible, included students from each of the specializations offered in the business school. We recognize that such large teams are not optimal for learning of all students and have experimented with many team sizes. The larger teams are used for several reasons:

1. The management of the industries is much easier and the strain on computer facilities is lightened.

2. students, most of whom do not like to participate in group activities, must now actively involve themselves in a semester-long group project.

3. students must use organizational skills and interpersonal skills.

4. Decisions must be made in smaller functional groups. Normally, there is more than one student from each of the three major functional areas in each team.

5. There are opportunities for students from the human resource area and from the HIS area to work on teal organization and systems problems as compared to the make-believe problems occurring within the functional framework of the simulation.

Decision Framework

After participating in a simulation using "MICROMATIC: A Management simulation" (Scott & Strickland, 1985) for twelve quarters. we had each student participate in a final examination which consisted of two parts: Part 1 (60% of the exam grade) involved individual decision making for two quarters. In Micromatic, performance is measured by a composite index of seven criteria. The range of scores earned across the ten industries was 0 to 100 (the "0" was coincidental since an index of less than "0" is possible). The instructors modified the basic program to eliminate chance factors which had been built into the stock price, and we eliminated random generators for shorted deliveries and production worker quits. We then made decisions for quarters 9 and 10 (the initialized game usually begins with the ninth quarter). In addition. a plant expansion was ordered with delivery to be made in quarter 11. These measures were taken to insure that chance would not enter into the results, and to provide a more challenging environment for the students. students were then required to make individual decisions for two consecutive quarters (11 and 12) with feedback on performance given at the end of each quarter. The individual participants were randomly distributed among ten industries.

Part II (40% of the exam grade) of the examination consisted of an essay question, written in a period between the decisions for quarters 11 and 12, in which students were to describe some aspect of their decision strategy. Grades on the essay part ranged from 27 to 38 with a maximum possible grade of 40.

Demographic data had been collected at the beginning of the semester on the student's specialization and history of grades in other courses. Additional data were collected on CPA, work activity, age, and educational background as well as on the decision making process, organizational style, and perceived level of influence during the regular simulation activity of the student's team.

The examination counted for 12.5% of the final course grade. Students were assured that regardless of the ranking of the index scores on the examination, nobody would receive a grade lower than a C on the examination. (We recognize that this statement to the students may have biased the results in that the poorer student would not make an honest effort. Our intent was to reduce the tension which would be associated with this type of exam.)

Hypotheses Tested

The following hypotheses were used as a basis for our analyses using a linear regression model:

Hypothesis 1: student-GPA has no relationship to individual performance in the test simulation.

Hypothesis 2: Grades earned in previous business administration courses have no relationship to individual performance in the test simulation.

Hypothesis 3: Grades earned in other parts of this course have no relationship to performance in the test simulation.

Hypothesis 4: Level of participation has no relationship to performance in the test simulation.

Hypothesis 5: The background of the student has no relationship to performance in the test simulation.

Hypothesis 6: Gender has no relationship to performance in the test simulation,

RESULTS

There were 144 usable responses. The average industry index score ranged between 66.8 and 85.4.

There were 12 to 15 students in each of ten industries. Since the values of the computerized index standing in an industry were computed relative to the performance of the best company in that industry, we were concerned that results may have been distorted by the different characteristics of the ten industries. Table I displays industry averages of key ratios and costs for the second quarter activities of all ten industries.

If the industries are significantly different, the index value received by a student in one industry might be significantly different had the student been placed in another industry, especially since the index used was based upon a comparison with the best performing company of that industry, A more valid comparison might be the relative increase in the net worth of the student's company as compared to the average increase in the net worth of the industry.

We did not pursue this issue and grouped the indices together from the various industries. However we did perform a one way analysis of variances of means a-cross the ten industries and were able to accept the hypothesis that the means are not significantly different from one another. These results are shown in Table II.

Table II: ANOVA ON INDUSTRY GROUP INDEX MEANS

Ind#	1	2	3	4	5	6	7	8
Mean	70.9	85.4	78.3	79.6	79.1	82.5	83.1	73.6
N	13	15	15	14	15	15	15	15

Ind#	9	10
Mean	79.2	66.8
N	15	12

F Ratio 1.22 Prob 0.291 (not significant)

One finding of considerable interest is that we found no correlation between the team performance in the semester-long simulation and the performance achieved by individuals on this exam. This finding raises a number of questions regarding the internal validity of simulation as a teaching technique, although one interpretation may be that students do learn even though their teams may not perform well in the competition. However, we do recognize that the larger team sizes may mean that the team grades are not truly reflective of the individual capabilities of all of the students.

Table III displays a simple correlation matrix for all of the variables examined in this study. The two parts of this examination, as previously described, were chosen as the dependent variables. GPA and grades earned by students in previous business courses are displayed as independent variable 1 through 8 (scale 0-4.0). Other dependent variables are described as follows:

X9-Exam I Grade (scale 0-100), the grade received on a mid-term exam which tested the student's basic understanding of the operation of the simulation.

X10-Team Participation Grade (scale 0-100). the grade received by each student based upon an evaluation by his/her fellow students during the regular simulation. Each student on a teat was asked to evaluate each of the other students as to their participation in the decision making process and as to their contributions to the decisions.

X11-Team Grade (scale 0-100), a grade assigned to each team at the end of the regular simulation based upon the computerized index assigned to each company. Each student on a team received this same grade as 25% nf the student's final grade.

X12-Case Grade (scale 0-100). a grade received on the first case study.

X13-Participation (scale 1-9), a self-perception of the student's participation in the regular simulation given by the student in a supplementary questionnaire using a nine point Likert scale.

X14-Learning (scale 1-9), a self-perception of the student's learning during the regular simulation obtained as for X13.

X15-Enthusiasm (scale 1-9), a self-perception of the student's enthusiasm for he regular simulation obtained as for X13.

X16-Influence (scale 1-9), a self-perception of the student's influence in the decision making process of the regular simulation obtained as for X13.

For our independent variables, Y1 and *Y2,* we see significant values of "r" for GPA, some previous business courses, other course grades with the exception of the simulation team grade, and for the self-perceived ratings. These findings would lead us to reject hypotheses 1 2, 3 and 4.

Since our major concern was to develop predictor equations, we developed regression equations using an interactive stepwise procedure. Table IV shows those which we found to be significant. Equations were

Table III
SIMPLE CORRELATION MATRIX
(Prob r=0 shown in ( ) for Prob=0.10)

VARIAB	Y2	Xl	X2	X3	X4	XS	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
EXAM 2 PART 1 Y1	0.19	0.31 (.02)	0.12 (.00)	0.17	-0.03 (.05)	0.21 (.01)	0.13	0.24 (.01)	0.11	0.17 (05)	0.31 (.00)	-0.02	0.25 (.00)	0.35 (.00)	0.24 (.01)	0.29 (.00)	0.19 (.03)
EXAM 2 PART II Y2		0.36 (.00)	0.05	0.01	-0.03	0.18 (.03)	0.14	0.19 (.03)	0.05	0.31 (.00)	0.44 (.00)	-0.10	0.22 (.01)	0.19 (.04)	0.02	0.23 (.01)	0.13
GPA X1			003	0.48 (.00)	0.36 (.00)	0.46 (.00)	0.55 (.00)	0.41 (.00)	0.45 (.00)	0.34 (.00)	0.34 (.00)	0.01	0.34 (.00)	0.38 (.00)	0.23 (.01)	0.37 (.00)	0.27 (.01)
ACCTNG I GRADE X2				-0.01	-0.23 (.01)	0.01	-0.05	0.13	0.08	0.01	-0.06	0.001	0.06	0.06	-0.11 (.07)	0.01	0.22 (.01)
ACCTNG II GRADE X3					0.1	0.01	0.32 (.00)	0.33 (.00)	0.24 (.01)	0.18 (.03)	0.17	-0.11	0.19 (.03)	0.27 (.00)	0.22 (.02)	0.3 (.00)	0.14
FINANCE GRADE X4						0.04	0.24 (.01)	0.05	0.16 (.07)	0.13	0.14	0.07	0.00	0.03	-0.11	-0.02	0.03
MGMT GRADE X5							0.13	0.30 (.00)	0.31 (.00)	0.14	0.17 (.05)	0.03	0.20 (.02)	0.13	0.05	0.05	0.20 (.03)
MARKETING GRADE X6								0.26 (.00)	0.17 (.04)	0.21 (.01)	0.30 (.00)	-0.03	0.19 (.03)	0.20 (.04)	0.11	0.30 (.00)	0.05
MICRO GRADE X7									0.4 (.00)	0.29 (.00)	0.25 (.00)	0.13	0.35 (.00)	0.23 (.01)	0.24 (.01)	0.27 (.00)	0.26 (.00)
MACRO GRADE X8										0.02	0.12	0.05	0.29 (.00)	0.19 (.04)	0.18 (.06)	0.20 (.04)	0.10
EXAM I GRADE X9											0.45 (.00)	0.03	0.12	0.39 (.00)	0.24 (.01)	0.35 (.00)	0.43 (.00)
TEAM PART GRADE X10												-0.10 (.01)	0.23 (.00)	0.57 (.00)	0.27 (.00)	0.43 (.00)	0.42
TEAM GRADE X11													-0.06	-0.02	-0.13	0.1	0.13
CASE GRADE X12														0.30 (.00)	0.23 (.01)	0.29 (.00)	0.08
PARTICIPATION X13															0.58 (.00)	0.64 (.00)	0.43 (.00)
LEARNING X14																0.70 (.00)	0.36 (.00)
ENTHISIASM X15																	0.49 (.00)

developed for the class is a whole, Y1. and for individual groups within the class. These groups were males, YM1, females, YF1, accounting students, YA1, marketing students, TM1, day students. YD1. and night students, YNI. A straight forward use of the stepwise procedure has the danger that variables might be selected which are based upon chance relationships. To avoid this possibility, initial efforts included all variables and then, several combinations were tried in the stepwise procedure eliminating the use of highly correlated variables. Dummy variables were introduced to separate males, and to separate accounting and marketing students from students in other specializations. These are listed as variables 17-19.

It can be seen that there is a significant difference between the equation for all students and those for specific groups. However, the results of one way ANOVA tests indicate that the differences in the means of the wale and female groups are not significant nor are the differences among specializations. For comparison between day and night students the F ratio was found to be significant at the 0.115 level.

While Hornaday and Wheatley (1986) found that accounting majors performed better than others, our results do not show this for all students but do show that male accounting students performed more poorly than other males and that female accounting students performed better than other females. Also female marketing students performed more poorly than other females.

Table IV
REGRESSION COEFFICIENTS
t-statistjc values shown in ( )

	VAR	Yl	Y2	YM1	YF1	YA1	YMKI	YD1	YN1
N		111	144	69	51	29	51	85	25
MEAN		79.2	33.2	78.1	81.2	79.1	78.9	77.5	82.1
R(sqr)		0.186	0.207	0.188	0.191	0.437	0.224	0.13	0.46
F		9.45	13.53	8.98	4.01	8.52	8.35	5.24	7.96
CONSTANT		-3.99	18.1	15.7	19.8	63.5	53.8	36.8	11.1
MGMT GRADE	X5	6.24 (2.85)			7.75 (2.32)	14.5 (3.94)		5.86 (2.34)	
MICRO GRADE	X7						10.74 (3.97)		
EXAM I GRADE	X9		0.017 (1.64)						
TEAM PART GRADE	X10	0.581 (3.01)	0.089 (4.12)	0.738 (4.22)				0.226 (2.56)	0.468 (1.39)
TEAM GRADE	X11					-0.743 (-2.07)		-0.337 (-1.40)	
CASE GRADE	X12		0.075 (1.64)						
PARTICIPATION	X13				4.17 (2.47)				
ENTHUSIASM	X15						4.96 (2.77)		5.43 (2.56)
LEARNING	X14		1.89 (1.70)						
MALE (DUN VAR)	X17						-5.2 (-1.21)		-16.08 (-2.73)
ACCTH(DUM VAR)	X18			-7.58 (-1.40)	10.7 (1.76)				
MKTG(DUM VAR)	X19				-11.8 (-1.96)				

Male marketing majors performed more poorly than female marketing majors, and male night class students performed more poorly than female night class students. Furthermore, the grade earned by accounting students in the Principles of Management course was a good predictor of success for them. Moreover, the management grade was significant for all students, females and day students. By contrast, the grades earned in the Principles of Finance and Principles of Marketing courses did not appear in any of the regression equations.

The team participation grade (an assessment by teammates) was also found to be significant for all students. males and day and night students. We could not reject the hypothesis that the night students did not out perform the day students as shown by our one way ANOVA test. It is reasonable that they should since they are more mature and experienced.

Another finding of note was that the performance on the essay part of the examination, Y2, had significant coefficients for the midterm exam and the grade earned on the case studies.

To summarize the findings we found evidence to reject all of our hypotheses, if not within the group as a whole, then within subgroups.

DISCUSSION

These results initially appeared to add one more study to those which find no relationship between academic ability, interests and background and performance in simulation. However, when one considers not only antecedents to participation, but combines them with performance in the simulation and then tests for results, it is shown that certain combinations of factors are significant for certain populations.

The example of accounting majors is of interest. Those who got good grades in Principles of Management did well in the simulation. The other elements of this equation were a negative result in the team grade and the self-report that the student was enthusiastic about the simulation. We suggest that those students who did well in management were inclined to consider that all facets of business are important for accountants to know, while the others may more narrowly define themselves as accountants.

The reason female accounting students did better may be due to a selection bias in our student population and many unobservable factors we could not consider. Although we could not show that performance is related to GPA we did find that the female students in the total population had a CPA of 3.1 compared to a GPA of 2.96 tot male students. We did collect data on age but did not include age in the present analysis. Nor did we look closely at differences between transfer students and students spending all four years at this school. These items remain for future studies. The most surprising finding for us is the importance of the grade earned in the Principles of Management course. We do not know how to explain this, but surely those of us in management departments will find it heartwarming! By contrast, the peer assessment of participation seems to be easily explained. Those who participate fully in the simulation learn how to do it well.

CONCLUSION

This study has raised as many questions as it has answered. While we found support for individual antecedents of performance in the simulation, it does appear that a combination of certain factors with the experience of the simulation can predict performance more precisely for certain groups. Future research is needed to explore these combinations in more detail. Such research might enable researchers to find the links between predictors of performance in simulations, internal validity, and long-term success of those who are taught through these means.

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