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PREDICTING PERFORMANCE OVER THE COURSE OF THE SIMULATION

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ABSTRACT

The purpose of this research was to study simulation performance over time. This was done by measuring performance and a variety of antecedent variables three times during a three year game. Using multiple regression analysis, the results showed that it is easier to predict later performance than earlier performance, and those motivated early in the game and participate in smoothly functioning teams perform better.

INTRODUCTION

This study concerns the prediction of simulation performance over time. It assumes that performance varies with time and its general purpose is to understand why and how that occurs.

Previous Research

Evidence from previous research identifies factors that predict simulation performance, and while the evidence is somewhat vague and contradictory, it is clear enough to draw some tentative conclusions. First students with high grade averages prior to the simulation perform better than students with lower academic standing (Grey, 1972; Wolfe, 1978; Seginer, 1980; Gosenpud and Miessing, 1983). Second, students majoring in some fields do better than those majoring in others (Wolfe, 1978; Niebuhr and Norris, 1980; Gosenpud and Miessing, 1983). In particular it has been Found that accounting majors perform better than non-Accounting majors (Gosenpud and Miessing, 1983) and that quantitative majors perform better than non-quantitative majors (Niebuhr and Norris, 1980). Third, students who play the game in teams that are cohesive perform better than those who play in less cohesive teams (Wolfe, 1975; Norris and Niebuhr, 1980; Miessing, 1982). Fourth. students who play the game in teams that are tightly organized perform better than those who play in loosely organized ones (Wolfe, 1975; Miessing, 1982; Gosenpud and Miessing, 1983; Miessing and Gosenpud, 1984). Finally there is one study (Gosenpud and Miessing, 1983) indicating that students who are highly motivated to play the game perform better than those less motivated.

One of the criticisms of the above studies is that time is not considered. Virtually all of the above studies measure performance only at the end of the simulation (while the performance rankings usually vary as the game proceeds) and virtually all measure such antecedent variables as cohesion only once (and these variables also change with time). A second criticism is that some of the predictive relationships reported are not predictive but concomitant. For example, Gosenpud and Miessing (1983) reported a relationship between performance and interest in the game as it progresses. However, interest was measured at the same time as performance. Therefore, it is not clear whether interest in the game was predicting performance or vice versa.

This study meets the above criticisms by looking at performance and antecedent variables at various times during the simulation. It looks at two types of antecedent variables which might predict performance: static properties of individuals such as CPA and major and variables which change with time such as cohesion. Its purpose is to predict performance over the course of the simulation in an attempt to understand how play proceeds over time, and it will answer the following six questions:

1. Is it easier to predict later game performance than earlier game performance?
2. Can performance at a given time be predicted from variables measured earlier?
3. Which antecedent variables are best at predicting simulation performance?
4. Are some variables better at predicting early performance while others better for later performance?
5. To what degree do static properties of individuals such as major predict performance?
6. Can performance be predicted from variables measured before the beginning of the game?

Antecedent Variables

As indicated above, two types of variables were identified as potentially predictive of simulation performance: those reflecting static properties of individuals (or static variables) and those that change as the game proceeds (or dynamic variables). The static variables reflect the academic and extra-curricular backgrounds of the students. The include the student's Accounting, Finance and overall CPA's, the number of Accounting and Finance courses taken, the number of group dynamics courses taken, the number of extra-curricular groups joined and the number of groups in which the student held office. Overall CPA was included because it was expected that those with higher GPA's would perform better in the simulation. Finance and Accounting CPA and number of Finance and Accounting courses taken were included because those with Finance and or Accounting experience were expected to perform better in the simulation. Number of group dynamics courses, number of extra-curricular organizations and number of offices held were included because those with such group experience were expected to organize their teams more effectively and therefore perform better in the simulation.

There were sixteen dynamic predictor variables. Eleven were continuous dynamic variables, and these were included first, because they were expected to change as the simulation proceeded and second, because they were found to be predictive of performance in one or both of two previous studies. Below is a list of the eleven variables. The first seven were found to predict performance in a study by Asbach, Kuenzi, Milton, Van De Bogart and Weber (1983). The next three were found to predict performance in a study by Gosenpud and Miessing (1983). The final two were found to predict performance in both of the above studies.

1. degree to which decision making was by majority rule
2. degree to which members were oriented towards human relations as well as task accomplishment (degree HR oriented)

3. attendance
4. degree to which members choose to meet to enjoy the experience as well as work (degree of enjoyment of experience)
5. informality of workload distribution
6. evenness of workload distribution
7. interest level
8. liking of teammates
9. degree to which teams worked together as opposed to autonomously
10. level of organization
11. formality of decision making

There were five dichotomous dynamic predictor variables, and these were included to measure changes in feelings towards teammates. These were

12. consistency of feelings for teammates
13. whether or not the group was initially a stranger group
14. whether or not each member pulled own weight
15. whether or not one person was uncooperative
16. whether or not the group was task oriented.

METHOD

Sample

The sample consisted of 80 seniors from two sections of a required Administration Policy capstone course at the University of Wisconsin-Whitewater School of Business and Economics. These students played the Tempomatic IV Simulation (Scott and Strickland, 1980), and game performance was worth 25% of the course grade. Classes were divided into teams of four and care was taken to include at least one Accounting major in each team.

Procedure and Measurement of Variables

In both sections, one of the three fifty minute sessions per week was devoted to the game. In the second of these sessions, the research was introduced by advising the students of the general purpose of the research and asking them to fill out four questionnaires during the term, In the first questionnaire, data was collected measuring the static properties variables of this study. In the others data was collected measuring the sixteen dynamic variables, and this was done after each year of the twelve quarter game.

Of the eleven continuous dynamic variables, interest level and liking of teammates were measured by four point Likert type questions; and level of organization, formality of decision making and degree to which decision making was by majority rule were measured by five point Likert type questions. The other six continuous dynamic variables were measured by bi-polar questionnaire items.

All five dichotomous predictor variables emerged from the answers to an open-ended questionnaire item on how feelings towards teammates had changed (or not) over the course of the game. Each of the dichotomous variables measures whether or not a particular answer was given to this open-ended question.

Performance was the numerical grade in the simulation. This grade was calculated from the students' relative position in sales (30% of the simulation grade), net income (20%), return on sales (10%), return on assets (10%), return on net worth (10%), earnings per share (10%), and stock price (10%). Performance at the end of year one was 25% of the students' simulation grade. The cumulative score at the end of year two was 33%, and the year three score was 42%.

Analysis

The major statistic utilized in this study was backwards multiple regression. Six such analyses were performed, two on each of three dependent variables: simulation performance after the first year of play (score 1), after the second year of play (score 2) and after the third year of play (score 3).

The two regressions performed on a given dependent variable differed in the kind of independent variables included in the initial regression equation. One included only variables measured earlier than the dependent variable (predictor variables) and the other included independent variables measured at the same time as the dependent variable as well as those measured earlier (predictor plus concomitant variables). For example, for performance at the end of year 3, predictor variables included static academic and background variables and dynamic variables measured at the end of years 1 and 2, while predictor plus concomitant variables included dynamic variables measured at the end of year 3 as well as static and year 1 and 2 dynamic variables.

The initial regression equation of each analysis included only a small number of the study's (up to) 69 independent variables. This was because many independent variables intercorrelated and only those variables that correlated less than [.20J with others were included. Of those variables that correlated greater than [.20] with others, those correlating higher (in absolute values) with performance were included. Those correlating less high were not.

RESULTS

Regressions using score 1, score 2, and score 3 as dependent variables are contained in tables la and b, 2a and b, and 3a and b respectively. Tables la, 2a, and 3a show regression using only predictor independent variables; tables 1b, 2b, and 3b show regressions using predictor plus concomitant variables. The rest of this section is organized according to the questions listed at the end of the introduction section.

1. Is it easier to predict later game performance than earlier game performance?

According to the results of this study, the answer is yes. The adjusted R square reported in table 3a (.286) is greater than that reported in tables 2a (.156) and la (.037), and the adjusted R square reported in table 3b (.372) is greater than that reported in tables 2b (.288) and lb (.196). Then, it does not matter if only predictor independent variables are included in the regression equation or if predictor plus concomitant variables are included. More of the variance associated with performance was explained when it was measured later in the game than when it was measured earlier. Thus it is easier to predict later performance than earlier performance.

2. Can performance measured at a given time be predicted from variables measured earlier?

Again, the results suggest a yes answer. Perhaps the most comprehensive result showing this is the adjusted R square of .286 with score 3 as the dependent variables and predictor independent variables only. This result indicates that 28.6 percent of the variance associated with final performance was explained by variables measured at least four quarters (and four weeks

Regression on Performance at the end of Year 1

a. Using Predictive Independent Variables

Variables in the Equation	Beta	Sig(t)	Variables Not in the Equation	Beta
Interest in Playing (T_0)	.224	.054	Overall GPA	.154
			Number of Finance Courses	-.117
			Number of groups in which student held office	-.112
			Number group dynamics courses	.077
Multiple R = .224	Adjusted R^2 = .037		F = 3.84	P = .054

b. Using Predictive and Concomitant Independent Variables

Variables in the Equation	Beta	Sig(t)	Variables Not in the Equation	Beta
Evenness of workload distribution (T_1)	.234	.039	Number of Finance courses	-.140
Whether or not each member pulled own weight (T_1)	.250	.027	Finance GPA	-.142
Attendance (T_1)	.235	.041	Formality of Decision making (T_1)	.054
Interest in Playing (T_0)	.185	.098	Consistency of Feelings for teammates (T_1)	-.078
			Degree of enjoyment of experience (T_1)	-.015
Multiple R = .494	Adjusted R^2 = .196		F = 5.07	P = .001

TABLE 2

Regression on Performance at the end of Year 2

a. Using Predictive Independent Variables

Variables in the Equation	Beta	Sig(t)	Variables Not in the Equation	Beta
Degree HR Oriented (T_1)	.207	.063	Whether or not group was initially a strong group (T_1)	.004
Attendance (T_1)	.326	.004	Whether or not each member pulled own weight (T_1)	.157
Number of Finance courses	-.220	.048	Number group dynamics courses	.026
Multiple R = .438	Adjusted R^2 = .157		F = 5.39	P = .002

b. Using Predictive and Concomitant Independent Variables

Variables in the Equation	Beta	Sig(t)	Variables Not in the Equation	Beta
Attendance (T_1)	.245	.036	Number group dynamics courses	.000
Interest in Playing (T_2)	-.415	.001	Interest in Playing (T_0)	.103
Cohesion (T_2)	.258	.028	Number of groups in which student held office	.095
			Level of Organization (T_1)	-.172
			Consistency of feelings for teammates (T_2)	-.172
			Degree of enjoyment of experience (T_2)	-.032
Multiple R = .543	Adjusted R^2 = .288		F = 7.65	P = .000

7

TABLE 3

Regression on Performance at the end of Year 3

a. Using Predictive Independent Variables

Variables in the Equation	Beta	Sig(t)	Variables Not in the Equation	Beta
Interest in Playing (T_2)	.440	.000	Extracurricular groups joined	.033
Attendance (T_1)	.271	.020	Finance GPA	-.067
Whether or not group was initially a stranger group (T_2)	-.198	.086	Degree of enjoyment of experience (T_2)	.103
			Evenness of workload distribution (T_2)	.033
			Consistency of feelings for teammates (T_2)	-.104
Multiple R = .570	Adjusted R^2 = .286		F = 8.48	P = .000

b. Using Predictive and Concomitant Independent Variables

Variables in the Equation	Beta	Sig(t)	Variables Not in the Equation	Beta
Interest in Playing (T_3)	.577	.000	Extracurricular groups joined	.134
Attendance (T_1)	.271	.032	Number of Accounting courses	-.013
Whether or not one person was uncooperative (T_1)	-.188	.100	Interest in Playing (T_0)	.087
			Whether or not the group was task oriented (T_3)	.153
			Formality of Decision making (T_2)	.107
			Degree HR oriented (T_1)	.166
Multiple R = .639	Adjusted R^2 = .372		F = 11.26	P = .000

in real time) earlier. This is a reasonably high adjusted R square given the fact that the independent variables are truly predictive (i.e., measured earlier) and given the uncertainty and complexity associated with the business simulation environment.

Other data supports the conclusion that later performance can be predicted from variables measured earlier. For example, interest at time 1 corrected higher with time 3 performance (r=.24, p=.018) than it did with time 1 performance (r=.10. p=.159), a difference in correlations which is significant at the .001 level (t=7.86).- This means that with the knowledge of interest in game at time 1, it is easier to predict performance at time 3 (two years in the future) than performance at time 1 (no years in the future).

Additional correlation analysis adds further support. Performance at time 3 correlated significantly with among others attendance at time 1 (r=.27, p=.008), attendance at time 2 (r=.25, p=.O~A), interest in the game at time 1 (r=. 24, p= .018) and interest at time 2 (r=.43, p=.001). These correlations suggest that those who attend meetings early and say they are interested early perform better later.

It is possible however, that the relationships between later performance on one hand and early attendance and interest on the other is mediated by early performance, that those who attend and are interested early are that way because they perform well early. To test this possibility, partial correlation analysis was performed; and the results were as follows: the correlation between interest at time 1 and time 3 performance was .24; controlling for time 1 performance, it was .23 (p=.020); the correlation between interest at time 2 and time 3 performance was .43; controlling for performance at time 2, it was .33 (p=.011); the correlation between attendance at time 1 and time 3 performance was .27; controlling for time 1 performance, it was .16 (p=.O81); the correlation between attendance at time 2 and time 3 performance was .25; controlling for time 2 performance, it was .06 (p=.197). These results show that early performance does mediate the relationship between late performance and early attendance, that it is possible that those who attend early and perform well later do so in part because they performed well early. The results also show that early performance mediates the relationship between early interest and late performance but to a lesser degree than that between early attendance and late performance.

3. Which antecedent variables are best at predicting simulation performance?

The data from Tables 3a and 3b show which independent variables loaded significantly on performance at the end of the game. They were attendance at Time 1 interest in the game at Times 2 and 3 (T_2 and T_3), not being in groups where one person was uncooperative at T_1 and not being in a group that initially was a stranger group at T_2. The data from Tables 2a and 2b indicate that performance at the end of year 2 varied with among others attendance at T_1, interest in the game at T_2, cohesion at T_1 and T_2 and the degree to which the team was oriented towards fun as well as working at T_1. The data in Tables Lx and lb indicate that performance at the end of Year I varied with among others interest in the game at T_0, attendance at T_1, whether all group members were pulling their weight at T_1, and degree to which the work was distributed

equally it is taken as a whole these results indicate that performance varies with motivation and smoothness of group functioning. The fact that performance consistently and significantly varied with attendance and interest in playing suggest that those who were motivated enough to attend meetings and say they were interested performed better. And the facts that performance varied directly with (1) cohesion, (2) equal distribution of work, (3) all members pulling their own weight, (4) and a group experience which was fun as well as constructive: and inversely with (1) the group being a stranger group at first and (2) the group having work load distribution problems suggests that groups perform better when their experience is smooth and constructive.

4. Are some antecedent variables better predictors of early performance while others are better predictors of later performance?

According to the results of this study, the answer appears to be no. The six tables in this section yield no consistent evidence of antecedent variables appearing as significant predictors of only early performance or as significant predictors of only later performance.

5. To what degree do static variables predict performance?

In this study static, academic and extra-curricular variables explained very little of the performance related variance when measured jointly with other variables. Table 2a shows that number of Finance courses taken loaded significantly on performance at time 2. (Beta = -.22; Pt = .048). None of the other of the static variables loaded significantly on any of the other dependent variables.

6. Can performance be predicted from variables measured before the game?

The answer to question number 6 appears to be no. Only two of the nine pregame independent variables loaded significantly on any of the three performance scores, and only two of the 27 correlations between the three performance scores and the nine pregame independent variables were greater than [.201.

SUMMARY AND CONCLUSIONS

This study's intention was to explain performance in the simulation over time. The study yields two important results. First, it was easier to understand why later performance varied than why earlier performance varied, and second, the results suggest that those more motivated performed better than those less motivated.

The following hypothesis combines these two results. Many students are motivated at the beginning of the game, and of course some are not, and the results indicate that many of those who are motivated early and continue to be motivated eventually perform better. These highly motivated people do not always do well in the beginning of the game because they are less talented, less prepared or make mistakes, but they eventually succeed because they decide to try. The regression results of this study do not show fully why these particular students decide to try, but they do suggest that those who attend early and say they are interested early perform better at the end.

The partial correlation data discussed earlier sheds some light on why some of those motivated early perform well later. These results show that relationship between first year attendance and early interest on one hand and final performance on the other was lower when the effects of year 1 performance was considered. This means that some of those who attended early and were interested early performed well late in part because they performed well early, that the relationship between early interest and attendance on one hand and later performance on the other was as high as it was because of correlations with early performance. So one of the reasons why some of those who were motivated early continue to try in the simulation and eventually perform well is that they succeeded early. There was early positive feedback to spur them on. And one of the reasons why some of those who were motivated early do not continue to try is because they did not succeed initially and there was negative feedback to discourage them.

NOTES

1. This uncertainty is due in part to the fact that the game is a relatively small proportion of a student's grade, students are not always motivated in their senior year and many try to out wit the game. There is additional potential randomness introduced by difficulties in measuring behavioral variables precisely.

2. Using McNemar's test (Psychometrika), Vol. 12, 153-157.

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