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CORRELATES OF LEARNING IN SIMULATIONS

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ABSTRACT

This study attempted to identify variables that correlate with learning in simulations. The researchers explored whether simulation learning varied with (1) simulation performance, (2) the degree to which players were struggling with the simulation, (3) type of simulation goals, and (4) common sense variables often associated with learning such as confidence. The subjects were college seniors; the simulation lasted eleven quarters; learning was measured by Instructor designed instruments; other variables were measured by questionnaire. The results were that students who expressed game related financial goals, such as to maximize profits, early in game learned more and that those that perceived the game to be understandable and simple early in the game also learned more. Learning did not correlate with performance and the degree of struggle.

INTRODUCTION

This is the fourth in a series of studies exploring the correlates of learning in Total Enterprise (TE) Simulations. All studies took place in the college classroom and are generalizable only in those settings. There are two general purposes for this research. The first is to understand why some students learn more than others In TE simulations or, to state in another way, identify behaviors and variables that are associated with greater learning in the simulation environment. The second is to determine whether there is a relationship between performance in the simulation, as measured by profit-related variables, and learning.

Previous Literature

Simulations are learning tools and are used extensively in learning environments, particularly in colleges and for training. One would expect then that learning would be the focus for a great number of research studies, and for business simulations that *has* been the case. Unfortunately, most of the research previously undertaken has not been helpful for the purposes of the present research.

Learning was a key dependent variable in some of the early research establishing the validity of simulations. Such researchers as Brenenstuhl and Catalanello (1979), Burns and Sherrell (1984), and Wolfe (1976) compared test scores of cognitive learning from lecture, case, and simulation sections of the same course. While such studies used learning as the criterion for such comparisons, their purpose was to assess the teaching methodologies and not to understand how simulations were helping students learn.

Studies focusing on factors influencing learning in simulations began to appear in 1989. Whiteley and Faria (1989) and Faria and Whiteley (1990) found that simulation games are effective in improving quantitative skills but not so in improving the acquisition of applied knowledge. Wellington and Faria (1991) examined the relationship between simulation participation, level of performance in a simulation competition, and recency of play with exam scores (presumably a learning measure). They found no relationship between simulation play and exam scores, level of simulation performance and exam scores, and recency of simulation play and exam scores. They suggested that simulation play involves skills which may not be directly measurable by normal multiple choice exams. Carvalho (1991) statistically examined the possibility of developing a learning validation model, which would permit instructors using simulations to develop course objectives with greater clarity by employing known characteristics of chosen games. The above studies appear to concentrate on the value of the simulation as a learning tool and on the kinds of learning enhanced with simulations. In contrast, this study presumes that learning takes place in simulations. It asks what factors enhance greater learning.

Learning and Performance

Common wisdom suggests that people who perform best in simulations do so because they have learned how to play the game better than most. And, Anderson and Lawton (1990) reported that 92.5% of simulation users in colleges surveyed used financial performance in the simulation as a determinant of a students grade. This implies that most simulation users behave performance influences whatever grades reflect (which presumably is learning). However many authors contend that the relationship between performance in the simulation and learning from it is weak or nonexistent. Greenlaw and Wyman (1973) and Thorngate and Carroll (1987) argue that simulation performance is due to luck (and therefore not due to learning). Burns, Gentry and Wolfe (1990) explain that performance can be affected by luck or other players performing poorly while learning Is the internalization of rules which might occur as a consequence of mistakes. Other than the studies done by the present authors, only three previous studies deal directly with the relationship between learning and performance. Teach (1989) found that forecasting accuracy (for him a measure of learning) did correlate significantly with measures of profits. As mentioned above, Wellington and Faria (1991) found no relationship between level of simulation performance and exam scores. Also, Anderson and Lawton (1992) found that only two of seven learning measures correlated with financial performance. These two were played down because both involved the comprehensiveness and workability of annual plans. Thus the authors concluded a paucity of significant results.

To summarize the previous literature on the correlates of learning, there is little in the literature that suggests why some learn more than others. There is evidence indicating that learning and performance do not covary, but there is little suggesting variables that do correlate with or predict learning in the simulation.

The Present Series of Studies

Our three previous studies (Wash bush and Gosenpud, 1993, 1994, & 1995) have all had purposes similar to the present effort. In each of the studies, correlations between learning and performance have been insignificant and near enough to zero so that we can comfortably conclude that there is no relationship between learning and performance at least for University of Wisconsin-Whitewater policy students. Regarding other variables in our 1993 effort, we found that learning was greater for members of teams that were either 1) in the middle of a competitive race to attain or maintain simulation standing or 2) improving in position. Learning was less substantial for teams that faced less competition and teams whose competitive standing was declining. We hypothesized that those who were trying or struggling would learn more and those not trying or coasting would learn less and tested this hypothesis in our 1994 and 1995 studies. The results show no relationship between struggle and learning. In addition in the 1994 and 1995 studies (unlike the results from 1993), there was no tendency for players either in competitive races or improving to learn more than players who were declining or coasting.

The Present Study

The present study is similar to the previous ones in that we measured whether a relationship exists between learning, on one hand, and performance and struggle on the other. In the present study, though, we proposed other variables that might predict the degree to which learning takes place. We proposed two sets of variables. The first set represents common sense reasons for why some individuals would learn more than others in any situation, and we propose two kinds of common sense reasons. The first kind lies in players' perceptions of the simulation. For some the simulation might be easy or interesting, therefore they would learn more; while others might find the simulation boring or difficult and therefore learn less. The second kind of reasons might lie in the emotional state of the individual. Some may be secure, motivated, confident, or improving and therefore learn more; while others might be afraid, unmotivated, not confident or declining and therefore learn less.

The second set of predictor variables involves goals. There are a few studies (Gosenpud, Miesing and Milton, 1984; Hornaday and Curran, 1988; and Curran and Hornaday, 1990) that have focused on the relationship between the degree of formal goal setting and simulation performance. The contention here is that the kinds of goals set may influence how much is learned In the simulation. So this study will attempt to ascertain if four kinds of variables influence learning performance, degree of struggle, variables commonly associated with learning such as confidence, and types of goals.

METHOD

Subjects, Research Design and Procedure

The subjects of this study were 46 students enrolled in two sections of the required undergraduate Administrative Policy course at the University of Wisconsin-Whitewater during the Fall 1994 semester. Each section compiled an industry, The Micromatic simulation (Scott et. al., 1992) was used in both, and both were taught by the senior author of this paper. The simulation length was 11 quarters in one industry and 13 in the other. Both industries were identical with respect to decision factor weights. Simulation performance was based on Net Income (40%), Return on Sales (30%) and Return on Assets (30%). The game was worth 20% of the course grade; 5% of the course grade was based on peer ratings of team contribution; 5% of the course grade reflected the score on an exam measuring learning in the simulation.

Learning

To measure learning, we developed two forms of a multiple-choice and short-essay examination. These forms were made deliberately parallel in form and content. The examinations were constructed using questions and situations routinely confronted by companies competing in Micromatic. These included manipulating and analyzing the marketing-mix, making operating decisions, determining costs of goods sold, understanding the consequences of doing or not doing ratio analysis or cash flows, and understanding the relationship between plant capacity and marketing expenses. The questions tapped analysis, synthesis, and application skills of the Bloom Taxonomy (Bloom, 1956). For all studies, Form I was administered as a pre-test at the beginning of the semester. Form 2 was administered at the end of the semester. Learning over the period of play was defined as the percentage score for Form 2 minus the percentage score for Form 1. The test developers used a common scoring key for all questions to ensure uniformity of measurement. Statistical reliability estimates for the instruments range from .65 to .7.

Other Variables

Struggle, goals and the common sense variables were measured three times, after the third quarter, as the results of the sixth quarter were returned to the students, and after the tenth quarter. The degree to which students were struggling was measured by two Likert-type questions, goals were obtained from an open-ended question, and the common sense variable information was obtained with fifteen bi-polar semantic differential items. Simulation performance was measured using the scoring routine in the Micromatic software.

RESULTS

Learning and performance

Learning scores correlated -.13 with performance at quarter 3, -.07 with performance at quarter 7, -.21 with performance at quarter 9 and .12 with end-of-game performance. None of these correlations were significant, suggesting that learning and performance do not co-vary.

Struggle and common sense variables

Table 1 shows the correlations between learning and the hypothesized continuous predictor variables Including the two struggle and the fifteen common sense variables. It shows learning did not correlate with whether or not individuals struggled with the simulation. Learning did correlate with some of the common sense variables, In particular those reflecting how well individuals seemed to understand the simulation early on. Degree of learning correlated significantly with how well students felt they understood the simulation at quarters three and seven and how simple they thought the simulation to be at quarter three. Although not significant, there was also a slight tendency for students who saw themselves as Improving to learn more.

TABLE 1: CORRELATIONS WITH LEARNING

	Qtr 3	Qtr 7	End of Game
STRUGGLE RELATED			
Struggling	.02	-.16	-.11
Not Struggling	.00	.21	.00
COMMON SENSE			
Threatening (intriguing)	-.11	-.10	-.05
Challenging	.16	-.24	.15
Improving	-.11	-.21	-.09
Scattered (Consistent)	-.17	-.07	.22
Falling	-.01	.06	.20
Safe	.06	.10	-.03
Hopeless	.00	-.14	.03
Rewarding	.13	-.17	-.02
Positive	-.03	.10	-.06
Simple	.32*	-.23	.17
Irrelevant	-.23	-.16	-.09
Regressing (improving)	-.27	-.17	-.01
Inert	-.27	-.23	.05
Confused (Understood)	-.33*	-.31*	.13
Stimulating	.15	.11	.01

* p less than .005

Goals

Table 2 shows learning scores as a function of expressed goals at various stages of the game. The mean learning score for the sample was .02, which means that the sample as a whole-averaged 2% better on the post test than on the pre-test. Table 2 shows that learning scores for students expressing certain goals were considerably higher than the overall mean, Learning scores were at least somewhat lower for students expressing other goals. Simulation learning was higher when learning, stock price, profit and expansion-related goals were stated, and lower when turn-around and competitive goals were stipulated. None of these differences were significant.

TABLE 2: LEARNING SCORE IF GOAL STATED

	Qtr 3 Mean	N	Qtr 7 Mean	N	End of Game Mean	N
LEARNING RELATED						
Expand knowledge	.013	6	.020	2	.040	
Learn Decision Making			.012	5		
Make Good Decisions	.037	3	.040	1		
Learn from Mistakes	.070	2				
Gain Group Experience	.040	1	.040	1	.040	1
Integrate Business Functions	.085	2	.075	2		
Total	.026	11	.035	6	.040	1
COMPETITVE GOALS						
Do Well (Comparatively)	.008	5	.018	4	.046	8
Not Finish Last	-.010	1				
Win	.014	5	-.032	5	-.010	1
Place in Top 2	-.038	4	.030	4	-.004	7
Move Up in Rankings			.043	4	.010	1
Stay at or Near Top			-.005	2	-.003	11
Improve	-.017		-.010	1	-.008	8
Total	-.008	17	.010	13	.009	23
PROFIT RELATED						
Make Profits	.052	11	.019	8	.004	10
Maximize Return on Sales			.005	1		
Reduce Expenses	.076	5	.038	6	.056	5
Match Capacity & Demand	-.010	1	-.100	1	-.025	2
Get out of Debt			-.050	1		
Total	.048	13	.010	13	.042	17
EXPANSION RELATED						
Expand	.050	5	-.020	1		
Increase Sales	.070	4	.020	4	.067	3
Total	.072	8	.012	5	.067	3
STOCK PRICE RELATED						
Maintain High Stock Price	.032	5	.037	3	.260	2
Issue Stock	.125	2	.018	4	.050	1
Total	.032	5	.025	7	.103	3
GRADE RELATED						
Get and A	-.070	1	.037	3	.080	2
Get Decent Grades					-.120	3
Total	-.070	1	.037	3	-.040	5

The results regarding expressed goals at quarter 3 seem meaningful. Students expressing goals associated with game related financial measures such as profits and sales early in the game seemed to have learned more. Those expressing competitive or grade-related goals learned less. Given that profits and sales are the ‘knitting of the game, then these results indicate that concentrating on the knitting early in the game helps one learn in it.

DISCUSSION

As in past studies, there was a near zero correlation between learning and end of game performance. This solidifies the conclusion that there is no relationship between the two variables. The fact that there was a .2 correlation between learning and performance at the games three-quarter mark deserves a bit of notice. It is possible (but in our eyes not likely) that learning correlates with performance rankings or indices *before* the end of the game and not rankings or indices at the end of the game. The fact that for the third time, there was no relationship between degree of struggle and learning weakens our confidence that a relationship exists.

Significant correlations did result between learning and simulation understandability and perceived simplicity of the simulation, early in its duration. There was also a tendency for leaning scores to be higher for those who set the goals in terms of financial indices instead of competitive or grade related ones. These two results suggest that the student's early approach to the simulation influences learning. In our 1995 study (Washbush and Gosenpud, 1995), those who lacked confidence to a moderate (but not an extreme) degree learned the most. Combined, these results suggest that those who want to perform well financially early in the simulation, understand the simulation, but are not confident learn relatively more, while those who don't understand the simulation and set competitive or grade-defined goals learn less. However, these statistical relationships are not strong and some are not significant, therefore we cannot be certain of these notions. They can serve as hypotheses for future research.

There are problems with this series of studies. First we have measured learning as most professors do, by tests. We do not know whether they are valid. We have attempted to develop our tests to reflect the environment of the Micromatic simulation and test for learning goals suggested by experts (Gosenpud and Washbush, 1994). However we only have superficial evidence (reports from the test takers) that the tests measure learning in the simulation. Other ways to measure learning have been suggested and these have not yet been incorporated into the present series of studies. For example, Carvalho (1991) has developed a scheme to measure competence in the skills demanded by the simulation. In this scheme, if success demands increased marketing expenditure, learning is assumed to occur if players increase their marketing budgets with time. Petranek, Corey, and Black (1992) argue that the real learning comes from reflecting, especially when the learner writes. These authors quote Francis Bacon who said, "Reading maketh a full man...writing an exact man." They report research on journal writing by Wollman-Bonilla (1989) who concluded that journals encourage understanding imaging, speculation questioning, and the shaping of Ideas.

Second, our results are not compelling. We are only relatively certain of a negative result, that is that there is no relationship between learning and performance. We are still not clear as to what associates with and influences learning in the simulation. The variables we are working with are difficult to precisely define and measure. We believe that our efforts have yielded data suggesting researchable directions. We believe that simulation facilitators will gain greatly with information about variables that enhance learning. Our research to date has identified neighborhoods of variables to explore. But the precise variables and relationships have yet to be found.

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