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ANTECEDENTS OF LEARNING IN SIMULATIONS

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ABSTRACT

This purpose of this study was to discover the why some students learn more than others in Total Enterprise Simulations. This study was undertaken using 71 senior policy students playing the MICROMATIC. Two measures of learning were utilized. One involved a test of analytical principles extracted from the MICROMATIC, and the second consisted of open-ended questions asking the students what they were learning. Very generally, the results suggest that learning is greater when learners are confident, interested, motivated, and understand.

INTRODUCTION

This is the fifth in a series of studies exploring the correlates of learning in Total Enterprise (TE) Simulations. Each of the previous studies had two purposes. The first was to determine whether there was a correlation between learning in the simulation and performance as measured by total net income and returns on assets and sales. With regard to this purpose, correlations between learning and performance have been close enough to zero in all of our previous studies (Washbush and Gosenpud, 1993, 1994 and 1995: Gosenpud and Washbush, 1996a) for us to safely conclude that there is no relationship between these two variables, at least for the simulation we use (The MICROMATIC) with students at our University (University of Wisconsin-Whitewater).

The second purpose of these studies and the sole purpose of the present study is to find out why some participants learn more than others in TE Simulations. Stated differently, we wanted to identify behaviors and variables that are associated with greater learning in the simulation environment.

Previous Literature

Previous research utilizing learning as a dependent variable has included research establishing the validity of simulations (Brenenstuhl and Catalanello, 1979; Burns and Sherrell, 1984; and Wolfe, 1976) and studies focusing on the value of and the kinds of learning enhanced with simulations (Whiteley and Faria, 1989; and Faria and Whiteley, 1990; Wellington and Faria, 1991). The above studies concentrate on (and therefore appear to question) the value of the simulation as a learning tool. They also focus on course learning, as opposed to learning specifically associated with the simulation. In contrast, this study presumes that learning takes place in simulations (thus presuming that simulations have value). This study asks what factors enhance greater learning from the simulation.

The Present Series of Studies

As indicted above, the purpose here is to discover variables that influence simulation learning. With regard to that purpose in our 1993 effort, we found that ‘earning was somewhat (but not significantly) greater for members of teams that were either I) in the middle of a competitive race to attain or maintain competitive standing or 2) improving in competitive position, Learning was less substantial for members of teams that 1) faced less competition or 2) were declining in standing. Therefore we hypothesized in 1994 and 1995 that those who were trying hard or struggling would learn more and that those who were coasting or not struggling would learn less. The results of those two studies show no relationship between struggle and learning.

In our 1995 and 1996 efforts, a few weak but significant relationships emerged which suggested hypotheses for future research. Students who set goals in terms of financial indices learned more and those who set goals in competitive or grade-related terms learned less. Also, learning scores were higher for those who said they understood the game and perceived it to be simple early in its duration.

The Present Study

The present study differs from previous ones in two respects. First, it differs in intention. Previously we intended to prove that the degree of learning varied with how much students were struggling to master the simulation and did not vary with how well they performed in it. This study is intentionally exploratory and seeks to discover which variables predict the degree of learning in the simulation.

Second it differs in its approach to measuring learning. In previous studies, we measured learning in the simulation by constructing an instrument using questions and situations similar to those confronted by MICROMATIC players. In the present study, in addition, we measured learning by simply asking students what they were learning. We assume, therefore, that students learn both what the simulation tries to teach and other not consciously intended (by authors and administrators) information, skills and attitudes.

While the constitutional right to privacy protects individuals from intrusive governmental actions, it does not necessarily constrain the action of private employers. A direct outcome of the debate over workplace privacy, therefore, has been a growing number of law suits and, as a result, an explosion of new statutory federal and state laws that increasingly restrict and control the manner in which employers collect, maintain, and utilize information about their job applicants and employees. However, despite the barrage of recent legislative actions, a great deal of uncertainty and uneasiness continues to exist regarding the interpretation, the scope of coverage, and the applicability of these regulations. Reflecting that uneasiness are the many recent human resource management articles that document a multitude of related litigation cases, many of which have resulted in less than clear-cut and often contradictory rulings (see for example. Kallman, 1993; Rosenblum, 1991; Mendelson & Morrison, 1988; Mendelson & Libbin, 1988).

Scenario #1

Scenario # 1 involved the issue of electronic Performance monitoring. Pagers and beepers now can track an employee's location twenty-four hours a day. Video cameras can be used to watch the employee's every move during the workday. Volume of work performed also can be monitored by tracking the number of keystrokes performed on the employees' computer. in fact, according to a J987 Office of Technology Assessment (OTA) report, several million employees in 60,000 companies, representing 20 to 35 percent of all terminal users in this country, were being electronically monitored (Kallman, 1993), and over 400,000 customer-relations conversations each year have been subject to supervised monitoring (Reynolds, 1993). Further, continuous electronic monitoring puts pressure on employees to work at the machine-established pace and leads to anxiety, fatigue, and apprehension. The results increase work-related stress, increase absenteeism and turnover, increase the number of on-the-job accidents and injuries, reduce performance, and even increase acts of sabotage (Kallman, J993; Reynolds, 1993).

Scenario #2

Scenario #2 involved the issue of drug testing. Concerns about ever-increasing healthcare cost and affordability of employer provided medical benefits also have resulted in a variety of controversial policies and practices that some consider to be invasive and intrusive to employees' private lives and freedoms. One of those areas increasingly coming under scrutiny is drug and alcohol testing. An American Management Association survey of AMA members, for example, indicated that 85 percent of survey participants were planning to conduct substance abuse tests on at least some of their employees in 1993. up from 52 percent in 1990 (Smith, J989).

Scenario #3

Scenario #3 involved the issue of monitoring of private off-the-job conduct. Concerns over the issue of privacy have been peaked recently, not only because such policies are affecting employees work lives, but also because they are increasingly touching more aspects of their private off-the job conduct. For example, employers have routinely inquired into whether job applicants smoke and/or how much they drink. Some, such as Turner Broadcasting System, have refused to hire smoker's altogether. Others, such as a property development firm in Georgia, have gone as far as not employing workers "who engage in hazardous activities and pursuits including such things as skydiving, riding motorcycles, piloting private aircraft, mountain climbing, motor vehicle racing, etc." (Schiller, 1991, p. 70). Further, according to a 1991 survey of human resource professionals conducted by the Society for Human Resource Management (SHRM), 17.5% of the respondents collected information on employee hobbies, 15.6% on credit history, 12.9% on substance abuse history, and even 0.4% on political affiliation (Losey, 1993).

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METHOD

Subjects, Research and Procedure for the Simulation

The subjects of this study were 71 students enrolled in four sections of the required undergraduate Administrative Policy course at the University of Wisconsin-Whitewater during the Fall 1995 semester. Each of this study's authors taught two sections. All students from each author's sections comprised one industry, so there were two industries, one of ten teams with 33 students and the other with twelve teams and 38 students. No team had less than three students; five teams had four. MICROMATIC (Scott. Strickland, Hofmeister, Thompson, 1992) was the simulation used.

The simulation length was 12 quarters in one industry and 13 in the other. In both industries, simulation performance was based on Net Income (40%), Return on Sates (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 the post test exam measuring learning in the simulation.

Variables and Procedure for Variable Measurement

Learning. We measured learning in two ways. We measured consciously simulation related learning with two forms of a multiple-choice and short-essay examination we had developed and used in previous studies. 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, and understanding the consequences of doing or not doing ratio analysis or cash flows. Many of the questions require analysis, calculations, and the application of principles from the MICROMATIC. Thus the questions appear to tap analysis, synthesis, and application skills of the Bloom Taxonomy (Bloom, 1956). For all industries, Form 1 was administered as a pretest 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. The second learning measure was open-ended. We simply asked students what they were learning while playing the game.

Antecedent Variables. Eight variables were chosen as potential predictors of learning in the simulation. They were chosen for common sense reasons, because they were thought to influence learning by educational, management, or simulation scholars, or because of previous research. Some were also chosen because they have been either predicted to or found to influence *performance* in the simulation and might also be significant predictors of learning in the simulation. The eight were academic ability, motivation, cohesion, organization, goals, struggle, perceptions of the simulation, and feelings toward the simulation.

Academic Ability. Academic ability was chosen because common sense suggests that ability enhances learning and because Vance & Gray (1967) and Wolfe (1976) predicted that ability would enhance performance in the simulation.

Motivation. Motivation was chosen because it is believed to affect performance in both educational and work settings (Atkinson, 1958; Porter & Lawler, 1960) and has been found to affect performance in academic (Sjoberg, 1984) and in simulation (Gosenpud & Washbush, 1996b) settings.

Cohesion. This variable was chosen because authors such as Bass (1982) and Cartwright (1968) hypothesize a relationship between cohesion and positive outcomes in learning settings and because Gosenpud & Washbush (1996b), Meissing & Preble *(1985),* and Norris & Niehbor (1980) found positive relationships between cohesion and performance in simulations.

Organization. Organization was chosen because of the common sense assumption that orderliness enhances learning and because Bass (1982), Mott (1972), and Mulder (1958) all found positive associations between orderliness and task accomplishment.

Goals. Goats were chosen because of the expectation that one's goals for a situation might affect how much he learns in it, and because Gosenpud & Washbush (1996a) found higher learning scores for those who set certain types of goals early in the simulation.

Struggle. This variable was chosen because Washbush & Gosenpud (1993) found that those in competitive races and those struggling to improve position in the simulation learned relatively more than those not struggling for position.

Perceptions of the Simulation. This variable was chosen because Gosenpud & Wash bush (1 996a) found a slight but significant association between learning and perceived simplicity of the simulation.

Feelings Toward the Simulation. This variable was chosen because Gosenpud & Washbush (1996a) found a slight but significant association between learning and the feeling that one understood the simulation.

Student goals, degree of struggle, feelings and perceptions toward the simulation, along with the open-ended learning were measured via questionnaire given after the third and sixth quarters of the game- goals and learning with open-ended questions, the two struggle questions with a likert scale, and perceptions and feeling information with 15 bipolar semantic-differential items (e.g., boring-stimulating; motivated-inert). Motivation, organization and cohesion were measured with a 57-item adjective checklist asking students which items characterized their experience in the simulation. Examples of items included orderly, communicating and lost. This checklist was given after the fourth and seventh quarters of the game. Academic ability was measured by asking students to write down their GPA.

Since the data for these variables were obtained via open-ended questions, student goals and self-reports of learning needed to be categorized. This was done by content analysis by the senior author. The content analysis yielded many relatively narrow categories of learning and goals and only a few broad ones. For example, after quarter 3, a) eleven players said their goals were to make or increase profits, b) six students expressed reducing costs of goods sold as a goal, and c) six stated that they wanted to reduce labor or inventory expenses. In this study, these were kept as separate categories, at 'east as the data were organized. Later for analysis, these categories were combined into broader categories. For example, a general profit goal included a), b) and c), above, a less general reduce expenses goal-included b) and c), and a more specific reduce labor and inventory expenses included only c).

RESULTS

Simulation Related Learning Measure

Stepwise multiple regression analyses were performed with the simulation related learning score as the dependent variable and all the continuous antecedent variables as independent variables, including University GPA, motivation, struggle, cohesion, organization, and feelings about and perceptions of the simulation. Two regression analyses were performed, one for each time period that antecedent data were acquired. Table 1 contains antecedent information collected after quarters 3 and 4, and Table 2 contains information collected after quarters 6 and 7.

First it should be noted that the Adjusted R Square is greater in Table 1 than in Table 2. Antecedent variables measured early in the simulation showed greater predictive ability than those measured later in the simulation, indicating that a player's early approach to the simulation influences the degree to which learning occurs.

TABLE 1
INFLUENCES ON LEARNING
ANTECEDENTS MEASURED EARLY IN THE SIMULATION

Adjusted R^2 = .3186
F = 6.96 Sig. = .0002

Variables in Equation	Beta	t	Sig.
Simple (simulation)	-.359	3.05	.004
Formal (group)	-.442	3.63	.001
Passivity	-.281	2.40	.020
Not Ambitious	.265	2.20	.032

TABLE 2
INFLUENCES ON LEARNING
ANTECEDENTS MEASURED IN THE MIDDLE OF THE SIMULATION

Adjusted R^2 = .1680
F = 5.24 Sig. = .0028

Variables in Equation	Beta	t	Sig.
Irrelevant (simulation)	.318	2.74	.008
Equitable (group)	.293	2.52	.014
Passivity	.254	-2.19	.032

Some of the results from these regression analyses are easy to interpret; others are not. Table 1 shows that those who perceive the simulation as simple early in its duration I earned more. This makes sense. It supports the notion that those who understand a phenomenon are better able to learn from it. And this result was found last year (Gosenpud and Washbush, 1996a). It also makes sense that members of teams that organize formally early in the face of an ambiguous task might be better prepared to learn from it, another result found in Table 1. But three of the relationships between learning and antecedent variables are more difficult to understand. Table 1 shows that players who were less ambitious early on learned more. Table 2 shows that members of teams that were less equitable learned more. And both Tables 1 and 2 show that individuals that saw their teams as passive learned more.

T-tests were performed comparing learning scores of those expressing certain goals for the simulation with learning scores of those not expressing such goals. The results pertaining to goals expressed after quarter 3 are contained in Table 3. Table 3 shows that those whose goals early in the simulation were to finish high in the standings tended to learn more (almost significantly so) than those not expressing such goals. However, learning scores for those who wanted to finish first were no higher than they were for those not desiring to finish first. Table 3 also shows that those interested in growing (either by increasing sales or capacity) early in the game learned significantly more than those not expressing an interest in growing, those wishing to improve or turn around learned significantly less than those not articulating those goals, and those interested in profit oriented goals learned no more and no less than those not expressing profit oriented objectives.

The results pertaining to goals expressed after quarter 6 are contained in Table 4. Table 4 shows no difference in learning scores between those expressing growth goals and those not expressing growth goals, between those expressing profit related goals and those not expressing profit related goals, and between those expressing improvement oriented goals and those not expressing such goals. On the other hand, those expressing expense reduction as a goal after quarter 6 did learn significantly more than those not expressing the goat of reducing expenses.

Open-ended Learning Measure

Analysis of the responses to the open-ended learning questions yielded 45 specific categories, and general categories were created from combinations of the forty-five. Correlations were produced between a particular learning category (general or specific) and this study's antecedent variables. Several of these correlations show interpretable patterns. For example, those who said they learned something about planning were not organized, were sluggish and saw the simulation as threatening. Perhaps those initially disorganized feel threatened but respond by learning to plan. Those who said they were learning specific principles of the game were well organized, and those who said they were learning about financial statements were comfortable and positive about the game. Perhaps, individuals who are comfortable and organized are able to pick up the game's principles and financially related skills more easily than those less comfortable and less organized.

These results also show a pattern among those whose answers to the open-ended learning questions suggested they were having a negative experience. Those who were discovering that they were making mistakes and needed to learn from them felt threatened early in the game. The strongest results, however, were for those whose answers to the open-ended question indicated despair or cynicism. Correlations indicated that these people, those who learned that the experience was hopeless or that the game was worthless, felt threatened, negative, punished, hopeless, regressing, and apathetic.

DISCUSSION

The general objective for this series of studies has been to understand why some students learn in the simulation and others do not. Although we have consistently contended and found that how well one performs in the simulation and how much one learns in it are not related, we have assumed that the attitudes and behavior *associated with performing* in the simulation do influence learning. In previous studies we have attempted to identify the influential attitudes and behaviors, with little success. With the present effort, significant results have been attained. Some of the results of this study confirm the obvious, some are interpretable, and we expect that some are generalizable and replicable. Others may be unique to this study. But from the results of this study, it will be easier to make empirically based hypotheses as to why some students learn in the simulation and others do not. This is encouraging.

What do these results teach us about learning in the simulation and what influences it? First we have begun to identify different kinds of learning. From the open ended learning results of this study, we've identified at least seven kinds of learning-- namely 1) building financial statement analysis skills, 2) learning to plan strategically and make decisions which adapt to the game's circumstances, 3) learning the game's cause and effect principles, 4) the importance of anticipating and planning for predictable and unpredictable future events, 5) learning to correct mistakes, 6) learning the game (and hopefully business in general) requires consideration of complex phenomena, and 7) balancing numerous perspectives and priorities. The first three are variables that form the foundation for the simulation learning measure used in this and previous studies. Answers to our open ended learning question suggest that many of the participants were learning these three skills, that is, financial statement analysis, understanding cause and affect principles, and strategic planning. But many of those answers suggest that students were learning additional things, namely skills four through seven of the above list and perhaps others.

Second, we have begun to identify variables that influence the degree to which undergraduates (at least) learn in the simulation. The results of this study suggest participant

TABLE 3
COMPARISONS OF LEARNING SCORES
BETWEEN THOSE EXPRESSING CERTAIN GOALS
AND THOSE NOT EXPRESSING CERTAIN GOALS AFTER QUARTER 3

Mean Learning Scores and Standard Deviations

	Expressing			Not Expressing				
Goal	N	Mean	SD	N	Mean	SD	t	p
To Win	10	2.10	4.71	59	2.96	4.11	0.55	0.595
Top Half Finish	10	4.80	3.02	59	2.51	4.27	2.08	0.055
Improve	23	1.34	4.04	46	3.59	4.08	2.17	0.035
Profits	23	2.54	4.15	46	2.87	4.22	6.39	0.699
Lower Expenses	13	2.62	4.34	56	2.89	4.17	0.21	0.832
Expand	22	4.61	3.60	47	2.01	4.19	2.65	0.011

TABLE 4
COMPARISONS OF LEARNING SCORES
BETWEEN THOSE EXPRESSING CERTAIN GOALS
AND THOSE NOT EXPRESSING CERTAIN GOALS AFTER QUARTER 6

Mean Learning Scores and Standard Deviations

	Expressing			Not Expressing				
Goal	N	Mean	SD	N	Mean	SD	t	p
To Win	Insufficient N for comparison							
Top Half Finish	Insufficient N for comparison							
Improve	21	3.16	4.13	51	2.58	4.13	0.52	0.606
Profits	28	3.46	4.46	43	2.28	3.93	1.15	0.256
Lower Expenses	19	4.42	3.67	52	2.13	4.19	2.24	0.032
Expand	28	2.59	4.44	43	2.85	4.01	0.25	0.801

perceptions of the experience, their motivation and confidence, the degree to which they feel organized, and their goals are associated with the degree to which they learn. Both in our 1996 study (Gosenpud and Washbush, 1996a) and in the present effort (see Table 1), participants who saw the simulation as simple as opposed to complicated learned more. In this study, the degree to which players saw the simulation as threatening influenced whether or not they learned to plan and whether or not to give up. In general those who perceived the simulation as simple, positive, and stimulating (opposed to boring) learned more. Being organized (orderly. disciplined. not disorganized) helped in learning about specific principles, but feeling disorganized helped in learning to plan better. Confidence early in the simulation influenced learning positively, as did feeling motivated. Those having certain goals for their simulation experience learned more. Those who wanted their companies to grow or expand, those who wanted to finish high in the standings early in the simulation, and those who wanted to reduce expenses in the middle of the simulation learned more.

So we are beginning to get an understanding of the behaviors and attitudes that help learning. Minimum confidence, motivation, and understanding are helpful, and it is good to feel positive toward the simulation and feel that the simulation is stimulating. It's good to have moderately ambitious goals for ones company early in the simulation and focus on reducing expenses later. Being organized helps to 'earn to analyze the financial' aspects and principles of the game**,** but to learn to plan, it is helpful to be threatened by the game and be disorganized.

Presuming they are generalizable, knowing these relationships should help those who teach and administer the simulation. For example, knowing that many perceive the simulation to be threatening is helpful in itself because it helps to explain the negative reactions to the simulation that we all

see. But this study's results point Out that many cope with the threat by learning to plan and plan strategically. Instructors can use this information to facilitate this coping tactic. The results of this study suggest that learners need to be minimally motivated and confident and that they need to see the learning exercise as interesting and doable. The results of this study then confirm what most educators know. Learning best takes place under certain conditions, it is not always easy to create the most optimal set of conditions, but this study's data suggest instructors should be working on to help students learn while playing the simulation.

One of the more important results, in our opinion, involves the set of responses to the open ended learning questions that suggested despair or cynicism. Ten of our 71 respondents' answers suggested helplessness or cynicism, and some of the studys strongest correlations were between many antecedent variables and whether or not answers were categorized despair/cynicism. These ten people, to a much greater degree than others, found the simulation to be boring, threatening, negative and confusing, They felt inert, dissatisfied, regressing, apathetic. It appears that when these people saw a negative term on one of the research questionnaires, they checked it. This is not news. We all know that there are undergraduates playing the simulation that are just really turned off. But to our knowledge, this phenomenon has not been confirmed empirically before. To the degree that this is a generalizable research study, then the fact that there is a sizable number of undergraduates that are negative toward the simulation and resistant to learning is now verified.

That said, the opposite also needs to be said. If ten of the 62 who answered the open ended learning questions said they learned how to lose or that the simulation was all luck or unrealistic, then 52 of 62 said they were learning something. And most of those said they were learning things that seem to be relevant. What this suggests is that the majority of simulation participants in this study found value in the simulation, value consistent with the goals of the authors and administrators of the simulation. These results were volunteered, as these were answers to open-ended questions. This is important. They were not framed by multiple choice or likert surveys. This data then represents the thinking of the students and adds support to the validity of simulations as learning exercises.

While this is the first study in our series, which produced positive, interpretable results, it still contains methodological flaws. The most serious of these involves the simulation related learning measure. To date there has been no formal validity studies on this instrument. The instrument reflects principles contained in the MICROMATIC, thus suggesting face validity. Studies indicate that students perform better on the post-test than the pretest (Washbush & Gosenpud, 1994), and there is evidence that students playing the simulation score significantly better on this measure than students not playing a simulation (Gosenpud and Washbush, 1993). So there is evidence that this instrument measures something that students gain from the simulation, but formal validity studies are necessary before we can have greater confidence in the results of this and similar studies exploring antecedents to learning.

ENDNOTES

1. A table of these correlations is available from the senior author.

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