

Developments In Business Simulation & Experiential Exercises, Volume 17, 1990

THE RELATIONSHIP BETWEEN FINANCIAL PERFORMANCE AND OTHER MEASURES OF LEARNING ON A SIMULATION EXERCISE

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ABSTRACT

Analysis was conducted to assess the relationship between financial performance on a business simulation exercise and various other measures of student learning. Financial performance was represented by a composite performance score that rated student companies based on net income, ROI, and ROA achieved in a competitive, computer-based management simulation. Little or no relationship was found between the performance score and the other measurements used to assess student learning.

INTRODUCTION

Assessing student performance on simulation exercises has been a source of discussion since their first use. It is common practice for instructors to use a team's relative financial performance as at least one measure of student learning and, consequently, as a means for assigning a grade for the simulation exercise. Anderson and Lawton (1989) reported 100% of those surveyed used financial performance as one determinant of a student's grade. They reported the weight assigned to financial performance ranged from 20 to 100% with a median of 30%.

The current research reported here was undertaken to assess the relationship between financial performance on a simulation exercise and other methods that assess student learning.

LITERATURE REVIEW

Simulation Performance and Learning

To date, little research has focused on the relationship between performance on a simulation exercise and other measures of learning. Whiteley and Faria (1989) note that research on business simulation exercises has been concentrated in three areas; (1) factors affecting the simulation learning environment and performance, (2) pedagogical factors, and (3) the benefits of simulation exercises versus other teaching methods. They cited four major review articles regarding business simulations by Greenlaw and Wyman (1973), Keys (1976), Wolfe (1985), and Miles, Biggs, and Schubert (1986). No research that directly focused on the relationship between financial performance and measures of student learning was reported.

Research that most closely related to the subject of this paper was conducted by Teach (1989), House and Napier (1988), Whiteley and Faria (1989), and Wolfe and Box (1987).

Teach (1989) assessed the relationship between forecasting accuracy and success on a marketing simulation exercise. He found forecasting accuracy regarding market share, unit sales, net cash flows, and profit/loss was directly related to firm performance in the simulation exercise. Teach noted the need to replicate these results using a total enterprise business simulation before there is a generalized equation between forecasting accuracy and simulated firm profitability.

House and Napier (1988) found the measures of net income, ROI and ROA to be the best indicators of financial performance on a business simulation exercise. These measures provide a global assessment of a company's performance, which encompass other financial measures. However, the relationship between financial performance and student learning on the simulation exercise was inferred, but not measured directly.

Whiteley and Faria (1989) analyzed whether incorporating a business simulation exercise in a marketing course would

improve the acquisition of knowledge of marketing concepts. They found *participation* in the simulation exercise did *not* improve the acquisition of either applied or theoretical knowledge. They did not report the relationship between performance on the simulation exercise and improved knowledge of marketing concepts.

Wolfe and Box (1987) reported the effects of team cohesion on performance on a business simulation exercise. They found cohesion was related to a team's economic performance. Their findings were consistent with those reported by Gosenpud, et al (1985). Neither of these studies mentioned the relationship between performance on the simulation exercise and other learning measures.

Thus, while numerous studies have probed various aspects of simulation exercises, little effort has been directed at assessing the association between performance on a simulation exercise and other measures of learning. Implicit in these studies is the assumption that financial performance on a simulation represents the learning which occurred during the exercise. However, Teach (1987) argued too much weight has been placed on profits as a measure of performance. He states measures of managerial performance should include the ability to accurately forecast events, operate within a budget, and allocate limited resources.

Measuring Learning

Bloom et al (1959) developed a system that classified learning into six levels. These levels are arranged in a hierarchical order to reflect progressively higher levels of learning. They are, in ascending order, basic knowledge, comprehension, application, analysis, objective synthesis, and objective evaluation. Gentry and Burns (1981) used this taxonomy in developing a research design for surveying users of simulations and experiential exercises. A summary of the levels, as presented by Gentry and Burns (1981), is shown in Figure #1.

FIGURE #1
BLOOMS TAXONOMY

| Learning Objective | Description of the Learning | Assessment Process |
|---------------------|---|---|
| Basic Knowledge | Student recalls or recognizes information | Answer direct questions/tests |
| Comprehension | Student changes information into a different symbolic form | Ability to act upon or process information by restating in his/her own terms |
| Application | Student discovers relationships, generalizations, and skills | Application of knowledge to simulated problems |
| Analysis | Student solves problems in light of conscious knowledge of relationships between components and the principle that organizes the system | Identification of critical assumptions, alternatives and constraints in a problem situation |
| Objective Synthesis | Student goes beyond what is known, providing new insights | Solution of a problem that requires original, creative thinking |

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|----------------------|--|---|
| Objective Evaluation | Student develops the ability to create standards of judgment, to weigh, and to analyze | Logical consistency and attention to detail |
|----------------------|--|---|

Anderson and Lawton (1988) described eleven different methods that can be used, alone or in combination, to assess student learning on a simulation exercise and their position on Bloom's learning hierarchy. They argued that no single assessment method is likely to provide a comprehensive measure of a student's learning on a simulation exercise. They urged using a combination of methods targeted at different levels of Blooms Taxonomy to provide a more comprehensive appraisal of learning achieved by students.

This research was undertaken, in part, to assess the relationship between financial performance on a business simulation exercise versus other measures of learning which occur in the simulation exercise. Methods described by Anderson and Lawton (1988) were used as measures of these levels of learning. The relationship between these various measures (including financial performance on a business simulation exercise) and the Bloom et al (1959) classification of learning is also presented.

RESEARCH METHODOLOGY

The Subjects and the Course

The subjects for this research were seniors in a required business policy course at a medium-sized, private, midwest college. The data were collected from two undergraduate sections taught by the same instructor during the same semester. There was a total of forty students in the two sections. The students were divided into two Industries of five simulation teams each, with eight teams of four, one team of three, and one team of five. The subjects were typical college seniors- in their early 20's, little work experience, attending day-time classes. The grading criteria (described below) were the same for both sections,

The Simulation

The simulation used was *Micromatic: A Management Simulation* by Scott and Strickland (1985). It is moderately complex, requiring a total of sixty-six decisions in the areas of production, marketing, finance, and accounting. A total of 12 decision sets (i.e., simulated quarters of operation) were made. Students were evaluated both on their performance in the simulation and on a number of written assignments and examinations associated with the simulation. The simulation exercise and related assignments accounted for 45% of the student's final course grade. The other major component of the course grade (50%) was based on case study analysis. This component was split equally (25% each) between classroom discussion of cases and four case papers. The remaining 5% of the course grade was based on a peer evaluation of team members.

Methods Used to Assess Learning

A total of eight different methods were used to assess student learning and knowledge on the simulation exercise. Each method is described briefly below. The methods were a mixture of individual and group measures. Each method is labeled with an "I" or a "G" to indicate how the data was collected.

The assessment methods used in this study were aimed at multiple levels of learning in Bloom's Taxonomy. Figure #2 shows the learning levels measured by these methods.

Quizzes on the simulation's rules and procedures (I). These quizzes consisted of a True/False quiz and a multiple choice quiz given before the first decision set and after the sixth decision set, respectively. These quizzes were used to measure the students' comprehension of the basics of the simulation exercise. Questions dealt with the environment of the

simulation; time lags and limitations of decisions plus basic rules of operation.

An exam on reading simulation output (I). This exam required students to read the output from a hypothetical company in their simulation exercise. From that output, the students were asked to recreate the decision Inputs made by that company. This exam, given after the last decision set, measured the students understanding of how their Inputs were reflected in the output.

Assignments on specific simulation decisions (I). These assignments focused on major decisions or issues students would face while managing their simulation company. These assignments involved analyzing manufacturing cost of goods sold; conducting a cost/benefit analysis for plant expansion; assessing the Impact of the marketing mix variables; and conducting a cost/benefit analysis for the purchase of labor saving equipment. These assignments were given after the second, fourth, and sixth decision sets respectively.

Evaluation of annual plans (G). Student teams were required to write annual plans covering their company's second and third years of operation. These plans were evaluated for their internal consistency, comprehensiveness, measurability of goals set, identification of distinctive competence and competitive position, and workability. No plan was written for the first year of operation. The absence of any experience with the simulation exercise at that point precludes the ability to write anything but the most superficial of plans.

Ability to accurately forecast sales (G). Student teams were required to predict their unit sales (i.e., their forecasted sales for the quarter) given the set of decisions they made. This exercise measured the team's ability to accurately predict the results of its marketing activities in its competitive marketplace. This in turn influenced the team's ability to plan its operations and financial strategies.

A scenarios assessment exam (I). This exam was administered after the simulation exercise had ended. It required students to assess possible responses to three different scenarios presented. The scenarios involved deciding between a mass marketing or a differentiation strategy, company products reaching the end of their life cycle, and the purchase of production equipment. The students were asked to list the questions they would want answered before making a decision on the scenario presented. While none of the scenarios were taken directly from the simulation exercise, the issues involved were very similar to situations faced in the simulation exercise.

Two instructors graded the three scenarios independently. There was a high degree of agreement between the scores given by the two instructors. The correlation between the scores assigned by the Instructors was .891.

A written analysis of simulation performance (G). Following completion of the simulation exercise, teams were required to submit a written analysis of their performance on the simulation. The paper covered their company's mission, goals, and successes and failures, including reasons for each. The papers were graded for their level of analysis, Comprehensiveness, support of statements made, and specificity of issues discussed.

Financial performance on the simulation (G) A composite performance index score based on net Income, return on assets, and return on investment was generated by the simulation program for each company. Weights given to each measure were 50%, 25%, and 25%, respectively.

FIGURE #2

| Assessment Method | Learning objective |
|---|---------------------------------|
| Quizzes on the simulation's rules and procedures. | Basic Knowledge |
| An exam on reading simulation output | Basic Knowledge & Comprehension |

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| | |
|---|--|
| Assignments on specific simulation decisions | Basic knowledge comprehension |
| Evaluation of written plans. Ability to accurately forecast unit sales. | Comprehension & Application Application |
| Scenarios exam on conceptual Issues | Analysis & Objective Synthesis |
| Financial Performance on the simulation | Application. Analysis. & Objective Synthesis |
| Analysis Paper | Objective Synthesis & Objective Evaluation |

Identifying a Group Leader

In addition to the eight assessment methods described above, students were also asked to assess the leadership qualities of their team members. The ability of each team member to influence decisions, to contribute to team morale and to Influence company economic performance were among the measures assessed through the use of a leadership questionnaire filled out by each team member. This score allowed the identification of a leader for each of the ten teams and permitted the analysis of individual effects on group performance. Information on the group leader was used in the analysis reported in Tables 1 and 2 shown below.

RESULTS

Correlation analysis was conducted to test for relationships between the measures of student learning and the student team's financial performance on the simulation exercise. Financial performance was determined by a composite score based on the net income, ROI and ROA a simulation company achieved. Table #1 shows the results of this analysis. (The r^2 is Minitab's coefficient of determination adjusted for the number of degrees of freedom.).

**TABLE 1
RELATIONSHIPS BETWEEN FINANCIAL PERFORMANCE
AND MEASURES OF STUDENT LEARNING**

| Learning Measure | Group Mean | | Group Leader | | Best Individual | |
|-------------------|------------|---------|--------------|---------|-----------------|---------|
| | r^2 | p value | r^2 | p value | r^2 | p value |
| Quizzes | 0.0 | NS | 0.0 | NS | 0.0 | NS |
| Output Exam | 0.0 | NS | 0.0 | NS | 0.0 | NS |
| Assignments | 0.0 | NS | 0.0 | NS | 0.0 | NS |
| Annual Plan 1 | 34.2 | .044 | NA | NA | NA | NA |
| Annual Plan 2 | 29.9 | .059 | NA | NA | NA | NA |
| Forecast Accuracy | 0.0 | NS | NA | NA | NA | NA |
| Scenarios Exam | 6.5 | NS | 1.8 | NS | 3.0 | NS |

NS = Not Significant
NA = Not Applicable

The Group Mean column shows the relationships between the average score of the members of each team on a given assessment method and the team's financial performance on the simulation. The relationship between performance on the simulation and the assessment method scores for the leader of the team and for the individual with the highest score in the team (i.e., the best individual) were also tested.

Table #1 shows that the only assessment method related to financial performance was the annual plan. The first annual plan written by the team was significant at $p=.05$, with a .34 coefficient of determination. The second annual plan was nearly significant at the .05 level, with a .30 r-squared.

It is not surprising that a team's score (or its annual plan was

related to its financial performance in the simulation. As mentioned above, scores on the annual report were based on the Instructor's evaluation of the annual plans comprehensiveness, internal consistency, workability, etc. Assuming the teams attempted to execute their annual plans, it would have been disappointing if no relationship had been found.

Financial performance was unrelated to scores for any of the other measurement methods, regardless of their postulated position on Bloom's taxonomy. It was anticipated that financial performance would be quite closely related to assessment methods aimed at measuring similar learning objectives (e.g., ability to accurately forecast unit sales) and less closely related to methods measuring lower level learning objectives (e.g., quizzes on simulation rules). However, the results show no relationship with any of the measures of learning (except for the annual plan), regardless of the level of learning involved.

Analysis was also conducted to test for relationships between measures of student learning and a team's written analysis of its performance on the simulation. This paper is an intellectual assessment of the team's performance on the simulation. As such, it is a qualitatively different measure of learning than financial performance, which presumably reflects a behavioral application of the team's assessment skills. Table #2 shows the results of this analysis.

Nine relationships out of a possible fifteen were significant at a p level of .05 or better. With one exception, the score of the

**TABLE 2
RELATIONSHIPS BETWEEN WRITTEN ANALYSIS
AND MEASURES OF STUDENT LEARNING**

| Learning Measure | Group Mean | | Group Leader | | Best Individual | |
|-------------------|------------|---------|--------------|---------|-----------------|---------|
| | r^2 | p value | r^2 | p value | r^2 | p value |
| Quizzes | 15.4 | NS | 66.8 | .002 | 32.3 | .050 |
| Output Exam | 67.1 | .002 | 76.5 | .000 | 73.8 | .000 |
| Assignments | 5.5 | NS | 33.4 | .047 | 17.7 | NS |
| Annual Plan 1 | 0.0 | NS | NA | NA | NA | NA |
| Annual Plan 2 | 0.0 | NS | NA | NA | NA | NA |
| Forecast Accuracy | 32.3 | .050 | NA | NA | NA | NA |
| Scenarios Exam | 56.3 | .007 | 0.0 | NS | 46.2 | .018 |

NS = Not Significant
NA = Not Applicable

group leader was more closely related to score on the analysis paper than was the mean score for the group or the score for the highest scoring (best) individual in the group. Only the score for the scenarios exam failed to show a relationship between the group leader's score and the analysis paper.

Table #2 indicates teams which performed well on the analysis paper had a leader and/or team member who generally performed well on the other assessment methods. Surprisingly scores for the annual plans did not show a significant relationship with the score on the analyst's paper. It was expected that a strong relationship would be found between the analysis paper and the annual plans given their proximity on Blooms taxonomy. This expectation was not supported.

Comparing Tables 1 and 2 shows that groups with leaders and/or individuals who performed well on other measures of learning performed well on the analysis paper. Unfortunately as shown by Table #1, teams with leaders/individuals who scored well on other assessment methods did not necessarily perform well on the simulation exercise itself. Reasons for this discrepancy were not evident. It may be that these leaders/individuals were not able to carry their analytical skills over to situations requiring behavioral versus Intellectual application. They may not have been able to convince others to follow their plan or they may have lacked the power to force adherence to their desired strategy.

Additional analysis was conducted to assess the relationships existing between the different learning measures. Table #3 shows the significant relationships between the measures of student learning. Only eight of a possible thirty-six measures were significantly related to another measure at a level of .05 or better. Not surprising, the two annual plans were significantly related to each other. The quizzes, assignments, and the output exams showed significant relationships. This was expected

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given that they measured accomplishment of the same level of learning, i.e.. Blooms basic knowledge learning objective.

**TABLE 3
MATRIX OF RELATIONSHIPS BETWEEN
VARIOUS MEASURES OF STUDENT LEARNING**

| | Quiz | Out-put Exam | As-sign | Ann. Plan 1 | Ann. Plan 2 | Fore-cast Acc'y | Scen. | Fin. Perf |
|-------------------|---------------|---------------|---------------|---------------|---------------|-----------------|------------|------------|
| Output Exam | 78.9% .000 | | | | | | | |
| Assign. | 50.6% .013 | 30.5% .057 | | | | | | |
| Plan 1 (Year 2) | 0.0% NS | 0.0% NS | 2.3% NS | | | | | |
| Plan 2 (Year 3) | 3.2% NS | .4% NS | 0.0% NS | 55.7% .008 | | | | |
| Forecast Accuracy | 24.8% .062 | 26.4% .074 | 25.1% .080 | 2.6% NS | 0.0% NS | | | |
| Scenario Exam | 6.9% NS | 5.0% NS | 29.7% .060 | 0.0% NS | 4.1% NS | 0.0% NS | | |
| Fin. Perf. | 0.0% NS | 0.0% NS | 0.0% NS | 34.2% .044 | 29.9% .059 | 0.0% NS | 1.8% NS | |
| Written Analysis | 66.8% .002 | 76.5% .000 | 33.4% .047 | 0.0% NS | 0.0% NS | 32.3% .050 | 0.0% NS | 0.0% NS |

Note: Where individual scores were available (Quizzes, Output Exam, Assignments and Scenarios Exam), figures shown in the Table represent the relationship between the group score and the group leader. Where no individual score was available (Annual Plans, Forecast Accuracy, Financial Performance and Written Analysis), the figures report the relationship between the two group scores.

top number = r2
bottom number = p-value
NS = Not Significant

DISCUSSION AND CONCLUSIONS

Anderson and Lawton (1988) postulated a strong relationship between financial performance on the simulation and Blooms learning objectives of application, analysis, and objective synthesis. As indicated in Figure #2, the measures of student learning assessed represent a number of different levels on Blooms Taxonomy. Contrary to expectations, there were very few significant relationships between the various measures of student learning and the students' financial performance on the simulation exercise. The lack of a significant relationship between basic knowledge of the simulation (quizzes, assignments, and output exams), conceptual understanding of strategic management issues (scenarios exam), or application (ability to accurately forecast unit sales), and the financial performance of the simulation company is disturbing. Given the length of the simulation exercise (12 decision sets), the effect or luck on results should have been minimized allowing performance on the learning measures to influence financial performance.

An Interesting question arises as to what financial performance on a business simulation exercise represents. Based on this research, it does not appear to represent basic knowledge and comprehension of the simulation exercise itself. Moreover, financial performance was also unrelated to assessment methods that were higher on Blooms taxonomy (the ability to accurately forecast sales and the scenarios exam). The question emerges as to what learning objectives are reflected in financial performance. Is it possible to "fall into" the right approach and then just replicate it? Can luck extend beyond a few decision sets? It seems more questions have been raised than answered. Given the results of this study, it would appear to be a mistake to rely solely on financial performance to assess student learning on a business simulation exercise. There may be too much noise" in the numbers to place much reliance on this measure as an evaluation of student learning. It seems that a

better reading of student learning may be gotten by using a variety of methods. Consideration should be given to using a written paper that analyzes the team's performance. The paper may provide a more comprehensive assessment of learning than does financial performance.

An additional finding in this study was that there appears to be little evidence of a hierarchical relationship among assessment methods. While relationships were found among several of the assessment methods, the correlation's among assessment methods that would seem to be aimed at similar levels on Blooms taxonomy were not uniformly high and, in fact, were sometimes weaker than the correlation's between assessment methods aimed at very different levels on the taxonomy. It is possible that the limitations mentioned below may account for this outcome. It may also reflect differences in ability to apply intellectual versus behavioral skills as suggested above.

A couple of limitations to the findings of this research should be noted. First, this was an exploratory study. While the number of student subjects was reasonably large, the number of simulation companies was small. However, the relationships between financial performance on the simulation exercise and the other measures were so weak it is doubtful that increasing the sample size would have changed the conclusions.

Second, It is not known to what extent the results of this study are unique to the simulation exercise used or applicable to simulations in general. Replication of this research using other simulation exercises is needed to clarify this concern. Of particular interest would be replication using simulation exercises that do not have a forecasting routine as part of the program. The ability to easily forecast the results of decisions made (if the forecasts are accurate) may help weak teams identify errors in their decisions before they are implemented. In other words, the user friendly simulation exercises may compensate for poor learning by students and, as a result, compress the range of financial performance achieved by the teams.

These limitations notwithstanding this research raises a fundamental question. What does financial performance on a simulation exercise reflect? Given the common use of financial performance by Instructors as an assessment method, its ability to reflect learning should be examined.

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