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THE ACQUISITION OF EXPERIENCE IN A COMPLEX MANAGEMENT GAME*

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This study was undertaken to evaluate a complex management simulation exercise as an environment for learning. The exercise was the Carnegie Tech Management Game; the players were students in a graduate management program who played the game. Players reported learning many kinds of things from their experience, but learning derived more from interpersonal interactions with other players and with outside groups like boards of directors than from interaction with the game model itself. Players may learn more about recognizing problems for future attention than about solutions of problems that can be applied in new situations. The kinds and amounts of learning vary with the length of game play, with team success or failure, and with individual job assignment on the team. They do not vary with measures of status on the team.

This study of how men learn and what they learn from participating in a complex management simulation exercise (or "game") was undertaken both to help assess the value of games as teaching devices and to derive some propositions about how people "acquire experience" in the ambiguous, complex environment that a game or real life presents. Assessment can help us decide what emphasis gaming should get in our educational programs. Propositions about how people acquire experience touch a kind of learning whose importance in human development has not been matched by attention from behavioral scientists. Both assessment and speculation about how people learn from experience should suggest ways to improve the design and administration of games.

A variety of efforts to assess the effects of management games are underway. Cohen and Rhenman [5] and Dill, Jackson, and Sweeney [9] summarize the subjective evaluations of many game developers and users. McKenney [15] has compared the power of a course based only on cases with the power of a course based both on cases and participation in a management game to teach basic strategies for analyzing business problems and reaching decisions. Robinson [19] is undertaking an experiment to compare games, cases, and problem papers as means of teaching decision-making skills in political science. Robinson summarizes the basic case for games this way:

> In contrast to other methods of instruction, games make students be more explicit about what they are doing, seeing, and hearing. Games give them quick feedback about the quality of their decisions. Games also heighten students' interest and motivation.
>
> As a result, games may be superior to other methods of instruction in producing learning which is general and structural and not bound to specialized

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content or issues, which integrates the processes by which decisions are reached with the substantive issues in the decisions, and which reinforces factual material provided through earlier reading or discussion.

All of these evaluations are preliminary and tentative, but all assume a greater potential for games in management education than the Ford and Carnegie reports did [10, 16].

We are not reporting a systematic comparison of games with other methods of teaching such as McKenney [15] has done or such as Robinson [19] has proposed. We draw from observations made during eight runs of the Carnegie Tech management game in 1959, 1960, 1961, and 1962 and from responses to questionnaires administered to the players mainly in 1961. From these, we have tried to generalize responsibly about the learning processes involved.[1] All runs were made with second-year students in Carnegie's M.S. program in Industrial Administration.

I. The Carnegie Tech Management Game as an Environment for Learning

A detailed description of the Carnegie Tech Management Game will not be attempted here since several are available [2, 3, 7], but an effort will be made to characterize it briefly as an environment for learning.

Of the several hundred management games now in existence, the Carnegie Game is probably the most complex. It is a general management simulation, with teams running firms in the packaged detergent industry and competing against each other for markets. Each set of decisions governs a month of company operations. Second-year graduate students organized in teams of 6–8 men play the game for a full semester. Each year there have been six teams, organized in two parallel but separate games, since the game program does not permit more than three teams to an industry. In 1959 and 1960, the game was required as an ungraded supplement to a full schedule of courses; in 1961 and 1962 the game was graded and counted as one course in the students' regular schedule. Usually teams were responsible for one to three sets of decisions a week, and for each set of decisions team members average 6–12 hours of work per man.

The game was not intended to teach specific concepts or techniques of management as we try to do, say, in a course in marketing or finance. It was designed as part of the integrative stem of our curriculum to challenge students to deal effectively with the kinds of problems that real executives face. Because real executives deal with a complex rather than a simple world, we wanted a game that provided a richer and more complicated challenge than other games posed.

[1] The senior author's sense of responsibility may be suspect because he participated in the design and development of the game and has written earlier papers predicting what the game would accomplish. The junior author, who has done the formal coding of data reported here, undertook the analysis with no prior experience with the Carnegie game or with its designers' hopes for it. Both of us have profited from independent summaries and interpretations of some of the questionnaire data that were prepared by William Fox of the University of Florida and by Donald Burns, formerly a student at Carnegie.

The simple games provided cogent reminders to players that decisions made in different areas of management and made at different points of time are interrelated and that the organization and procedures for making decisions have consequences for the quality that results. We wanted a game which in addition would help students develop:

1. An ability to seek out and evaluate information from the mass of data that a complex and diffuse environment makes available and an ability to organize it so that it provides a useful guide to future decisions.
2. An ability to forecast, plan, and take action to achieve planned outcomes in a situation where there are hundreds, rather than dozens, of variables to be coordinated and controlled.
3. An ability to combine the role of generalist and specialist and to handle decision problems whose solution rests on imaginative and thorough analysis as well as those whose solution rests on fast, intuitive judgments.
4. An ability to work effectively with other people on the team and with groups outside the company.

To develop these skills, the game is designed and administered to provide four major kinds of experience: analytic, negotiating, organizational, and reflective. *Analytic* experience refers to the job of interpreting the history of the simulated company which a team runs and of making new sets of decisions which—in interaction with other teams' decisions and with the computer model—will insure the company's survival and growth. Here the students are working with qualitative and quantitative outputs of the computer and are trying to discover how they can set their decisions to generate the kinds of outputs they desire. The decisions which each team makes cover a wide range of managerial functions, and the number of decisions which a team must consider for each "month" of company operations is between 100 and 300. The team has the opportunity to develop complex programs within each of the functional areas, but faces the continuing challenge of making the programs and proposals for action fit with each other and with the overall goals of the firm.

Negotiating experience arises from requirements that the teams deal periodically with the kinds of outside groups that the management of a real company would have to work with. The primary external group is a board of directors (made up of faculty members with, for some 1961 and 1962 teams, an executive from industry). The boards act as company directors do in real life. They meet with the teams five to seven times a semester to hear reports about company performance and plans and to approve major decisions. They can question team members and give them special assignments, but they do not "teach" students how to run the company. Other outside groups with whom the teams have dealt have included auditors (played by first-year students in 1960, 1961, and 1962) and union representatives (played by faculty members in 1961 and 1962). The auditors do an audit of financial statements for the first "year" of play, evaluate management's decision-making and control procedures, and make a report to management and the board of directors. The union representatives can introduce grievances at any time and intervene near the end of the first "year" of play to negotiate a new wage contract with the teams.

Organizational experience comes from the challenge of designing, setting up, and maintaining a team organization that can cope with the analytic and negotiating tasks and that can survive as a functioning unit until the end of the semester. The job is complicated because the boards of directors require the teams to define formally both a structure and rules of operation for themselves and expect the teams to justify their plans. The analytic task is complex enough to reinforce the boards' demands for organizational planning. All teams differentiate on the basis of function, so that different members are in charge of relatively limited areas of the company's activity. Most teams also establish a status hierarchy, with a president or chairman who is expected to lead and to coordinate and with one or two levels of management below him. Boards may—but seldom do—ask for men to change job assignments midway through the game.

Reflective experience during the game comes largely from assignments made in other courses that build on what is happening in the game. There are two kinds of reflective assignments to which most students have been exposed. One kind, in conjunction with a course in the administrative process, asks them periodically to discuss or write about the organization of their team: ways in which it has developed, the motivations of its members, its approaches to particular kinds of problems. The other kind, part of a course in operations research methods, asks them to take a problem from the game which is amenable to an operations research approach and to develop a solution using the techniques that they have learned.

Some early discussions of the educational effects of games [17, for example] stressed the links between these effects and the basic design of the game model, i.e., the learning that comes from the analytic experience which a game provides. As we become more familiar with what games can do, though, it becomes increasingly clear that the total design of a management game includes not only the computer model but the procedures for running it and for fitting it into the curriculum which determine the negotiating, the organizational, and the reflective experiences that students get.

II. Observations of the Learning Process

Earlier papers from Carnegie [4, 6, 8, 14] have reported in a general way how teams organize, how they react to the game, and what they learn.[2] With additional observations by faculty directors and with questionnaire data from students in the 1960 and 1961 runs of the game, though, we can now be more specific how learning occurs in the game. In this section, we summarize our major findings about what students learn; about changes in the pattern of

[2] Although the focus in this paper is on student learning from participating in a game, it is clear from our experience and from the experience of others (9) that this is not the only learning which takes place when schools get involved with games. The designers of games learn about the structure of the world and about techniques of simulation as they build and modify game models, and faculty members learn something about the effectiveness of previous teaching when they see how well students can cope with the problems that a game poses.

learning as play progresses; and about relationships between learning and such variables as motivation, position on the team, and prior experience of special kinds that students bring to the game.

Observed changes in players' behavior

By watching teams as a faculty director and by looking at company performance, it is clear that performance within the game improves during the semester of play. Much of the improvement is in their ability to handle the analytic tasks which the computer model and the actions of their competitors pose. They do become quicker and more sophisticated about abstracting, organizing, and using information from a complex and diffuse environment. They recognize better the differences between valuable and trivial information. They make more elaborate and subtle inferences about the relation of past results to future decisions. They coordinate information and actions more effectively among the separate functional areas of marketing, production, and finance.

Their forecasts generally improve in accuracy, and their plans are based on more rational assumptions. They learn in a variety of contexts—planning market research expenditures, scheduling equipment maintenance, budgeting advertising, or planning a new factory or warehouse—how economic concepts like marginal analysis or return on investment apply to specific management decisions. They gain experience with the power—and the limits—of quantitative decision rules. They become more careful about testing specific decision proposals against general policies they have agreed on, and they see more clearly the interactions between current decisions and future competitive position.

In working with outside groups like the boards of directors, they get good practice in expressing themselves to a skeptical and sometimes hostile audience. Over the course of a semester, we usually notice improvement in the level of preparation for meetings, in the skill with which ideas are presented, in the tenacity with which ideas are defended, and in the subtlety with which teams control the agenda of meetings and the direction which discussion takes.

Within their organizations, students become more sensitive to the factors involved in establishing and maintaining effective working relationships with their teammates; and they get better at anticipating and solving the problems of coordination and control which the game poses. They have varying degrees of success in setting goals and schedules, in meeting deadlines, and in handling problems of motivation and influence within the team.

The level of learning

We had hoped that learning in the game might be learning "in depth" that students could and would transfer readily to new situations. As Robinson [19] points out, many people have argued that games make students more explicit about what they are doing and produce learning that is "general and structural," rather than being bound to specialized content or issues. Impres-

sions that this is so are still held firmly by most faculty observers of the game, but firm evidence has been hard to find.

There is no doubt that a great deal of what students learn is partial learning or pertains only to playing the game more effectively. Without stimulation or assistance to make learning explicit or to generalize, they may not apply their experience outside the game. After the 1961 run, we asked the players to write down what they had learned from playing the game. We coded the answers; and as Table 1 shows, almost two-thirds of the statements about what was learned simply reflected new recognition that certain problems exist for managers. This is an important kind of learning, to be sure, because many of management's failures are failures to recognize or acknowledge problems. But it can still be regarded as a lower level of learning than learning in a specific or general way how to deal with a problem. Only three per cent of the statements were explicit, specific descriptions of the solutions or strategies that had been learned.

Interviews with team members after several of the game runs reinforce the questionnaire findings. It is easy to get good suggestions from players about how they would change their behavior if they were to play the game again. It is much more difficult when you ask for more general kinds of learning to get players to move from statements of what they "learned about" to statements of what they "learned".

A desire to increase both the explicitness and generality of learning in the game has been a primary motivation in our adding reflective assignments in other courses. These are "off-line" assignments as far as game play is concerned, but they stimulate students to review and extend their game experiences. The reflective assignments in both the administrative process and the operations research course have been judged by the instructors as very productive. The success of the operations research assignment stemmed from the motivation students

TABLE 1

Coded References to Levels of Learning (1961 Runs)

Level of learning (main code category)	Per cent of references (n = 126)		
	Observed	Expected I (Equal chance, main categories)	Expected II (Equal chance, subcategories)*
Problem recognition.....	66%	33%	50%
General Solutions.....	31	33	38
Specific Solutions.....	3	33	12
Totals.....	100%	100%	100%

Results of chi-square test: p (Obs. same distribution as Exp. I) < .001
p (Obs. same distribution as Exp. II) < .01

* Computed because the number of possible subcategories into which an answer could be placed as an example of "problem recognition," as an example of a "general solution," or as an example of a "specific solution" were unequal. Hence if coding were done on an entirely random basis, by subcategories, 50% of the answers would have been coded as "problem recognition," etc.

had to choose complex problems whose solution was important to their performance in the game and from the experience students got with the difficulties of adapting operations research techniques to the problem they had chosen and the information they had to work with. The success of the administrative process assignments stemmed from the fundamental difference between students' approach to problems that are their own and problems that are someone else's. The teams had to contend with many of the classic problems of management organization that people have written textbooks and cases about. Frequently in a case discussion, students will argue that the best solution is to hire a more intelligent group of managers. But since in the game, their own attitudes and behavior had created the problems, they could not so easily dismiss the task of learning how to prevent or solve them.

While we would like still to find ways to increase what students take out of the game, there is at least one dimension in which the game has had more impact on future behavior than other devices, such as case studies and field projects, which we have used at Carnegie to give students experience with "the real world." Problems which the game raises have caught the interest of many students and become the focus for further work in courses or on the students' own time. The yield so far is at least four published papers [8, 11, 12, 13] and the beginning of several doctoral dissertations.

The dominance of interpersonal experiences as a source of learning

Although many kinds of learning occur in the game and although students may spend more time working alone with data and decisions than in working with one another or with faculty directors, students remember what they learn from interactions with other people more vividly than they remember what they learn from working on the analytic tasks in the game. For example, after the 1959 run, one of the teams met with its board of directors and with other interested faculty members for an intensive informal discussion of what they had learned. Of the six teams that year, this was the one which from the beginning had the best morale and the smoothest running organization. It was also the most profitable firm in the industry. Yet roughly half their comments pertained to organizational learning; for example,

> I learned a great deal about coordination and what it really means and what is needed to get it done.
>
> You must make definite decisions in a limited time—even when you have little time to work on them.
>
> We had to be able to justify things (to the Board) as well as to get them done.
>
> One thing we naturally did . . . was to establish routines and to set things up so that they would become easier. . . . This allowed us to place greater emphasis on longer range planning in all areas.
>
> I have learned to look for influence patterns and have learned about their

TABLE 2

Coded References to Learning Derived from Different Sources (1961 Runs)

Kind of learning (main code category)	Per cent of References (n = 126)		
	Observed	Expected I (Equal chance, main categories)	Expected II (Equal chance, subcategories)
Team-derived	76%	33%	51%
Externally-derived	12	33	23
Model-derived	12	33	26
Totals	100%	100%	100%

Results of chi-square test: p (Obs. same distribution as Exp. I) < .001
p (Obs. same distribution as Exp. II) < .001

importance in a way which I don't think I would have got just from the courses only.

More evidence of the greater impact of interpersonal modes of learning comes from the 1961 runs. At the end, students were asked to write a brief summary of what they had learned. These summaries were coded on several dimensions, one of which was designed to assess how much of the learning was:

Team-derived; i.e., derived primarily from the experience of participating as a member of a small group.

Externally-derived; i.e., derived primarily from experiences with outside groups like boards of directors, auditors, and labor ngotiators.

Model-derived; i.e., derived from experiences with the computer model, with the rules of play, and with the tasks of making good management decisions.

Of these three sources of learning, the first two are primarily interpersonal; the third is primarily impersonal.

Even if we allow for the fact that there were more subcategories for coding *T-D* learning (20 subcategories) than for coding *E-D* (9) or *M-D* (10) learning, most of the reported learning stemmed from participation in team activities. As Table 2 shows, only 12 per cent of the coded responses[3] reflected impersonal, model-derived learning.

Looking at the same thing another way, of 42 students who had at least one coded response, 29 (69%) referred *solely* to learning that resulted from experiences within the team or with outside groups (see Table 3). No respondent referred solely to learning from experiences with the game model. Even allowing for the crudeness of the coding process used, the emphasis on interpersonal learning is greater than we would expect by chance alone.

Although we might also expect that learning derived from interpersonal experiences would be more explicit than learning derived from interaction with

[3] The median number of coded responses per student was 3; the range for 43 students was 0–5. Coded units could represent passages varying in length from a phrase to a paragraph or more.

TABLE 3

Variety of Students' References to Different Learning Sources (1961 Runs)

Mix of learning references	Per cent of Respondents (n = 42)		
	Observed	Expected I (Equal chance, main categories)	Expected II (Equal chance, subcategories)
Solely team or externally-derived...	69%	33%	46%
Mixed of team or externally-derived and model-derived.....	31	60	50
Solely model-derived.....	0	7	4
Totals.....	100%	100%	100%

Results of chi-square test: p (Obs. same distribution as Exp. I) < .001
p (Obs. same distribution as Exp. II) < .01

the model, there was no evidence that this was true. We looked to see if *T-D* learning and *E-D* learning were more explicit than *M-D* learning. All responses were coded to show whether they simply indicated learning that certain kinds of problems existed or whether they indicated that general or specific solutions to the problems had also been learned. Interpersonal learning was not more explicit, by this measure, than impersonal learning: Of 111 references to *T-D* or *E-D* learning, 38 (34%) reflected learning of solutions. Of 15 references to *M-D* learning, 5 (33%) reflected learning of solutions.

Changes in learning as the game progresses

As a supplement to asking players what they have learned on the 1961 questionnaire, we also asked, both at the beginning and at the end of the game what they saw as their main challenges—as the main things they had to learn. One would hypothesize that the main challenges a team perceived would change as the game progressed and that in the Carnegie Tech game, the progression might be the following:

Initial focus on problems of organization. The boards of directors want a plan of organization; the team members want to agree on organizational arrangements to reduce the amount of ambiguity and uncertainty they have to contend with; and the magnitude of the total game task relative to the time available for play requires that a team organize early if it is to do even an adequate job of running its company.

Subsequent focus on problems of maintaining the firm as an operating entity. Once organized and once past the first two or three sets of decisions, teams are in a reasonable position to begin trying to outguess their competitors and the computer model and to begin looking for rational rather than random rules for selecting among decision alternatives. Teams are under pressure from their own leadership and from the boards of directors to build a strong, stable competitive position for their firm—usually to aim for 40–45 per cent of the market and profits in a three-team industry.

Still later, primary interest in challenges of experimentation and innovation. Once a team has organized and stabilized its competitive position, if it does not lose interest in the game, its major challenges lie in seeking ways to enliven play for themselves and competitors and in exploring alternative strategies that it could not afford to try when it was trying first to understand and control its environment.

The differences between what students saw as challenges before and after the game in the 1961 run reflect this sequence of challenges. Students were asked at both points to list the problems they saw for themselves (1) in making an effective personal contribution to the work of the team, (2) in helping the team achieve a good record of profits and growth, and (3) in dealing with the board of directors. Answers were coded in two ways.

The first coding was of the answer as a whole: to what does it give primary emphasis? Problems of personal adjustment and team organization? Problems of controlling interactions with the game model and with competitors? Problems of relations with the board? Answers which stressed the first of these were judged to be stressing organizational issues. Answers which stressed the last two were judged to be stressing maintenance of the company's position and innovation to improve that position. (It was not possible in the answers to discriminate reliably between maintenance and innovation.)

As Table 4 shows, the heaviest pre-game emphasis was clearly on organizational challenges; the heaviest post-game emphasis, on problems of maintenance and innovation.

The second coding was a more qualitative analysis of answers to the three subparts of the question separately. This coding checked with the first. The stress on problems of individuals' fitting into the team or on problems of the team's working together effectively dropped off sharply during the game both in numbers of people mentioning such challenges and in the length of the answers given. The stress on game maintenance factors roughly doubled.

Both pre-game and post-game, the two most frequently named personal challenges were those of living within the time constraints that the game imposed and those of maintaining personal interest in the game. Otherwise, the

TABLE 4

Pre-Game to Post-Game Shifts in Main Challenge of Game (1961 Runs)

Pre-game: number of students naming	Post-game: number of students naming			
	Pers. & team	Game mgt.	Rel. w/Board	Totals
Personal or team challenge	6	17	3	26
Game management challenge	1	6	0	7
Relations with board challenge	1	0	1	2
Totals	8	23	4	35

Results of chi-square test: p (post-game same distribution as pre-game) $< .01$

pre-game personal challenges were mostly reflections of ambitions for self-development: the need to develop qualities like patience, sociability, tolerance, ambition, or aggressiveness or the need to acquire certain kinds of knowledge. After the game, though, the secondary personal challenges had little to do with self-development. In their place were the problems of the "organization man"—how to submit gracefully to team objectives or team practices that you do not agree with.

The stress on team matters also shifted in nature. Before the game, players wrote about themselves as individuals in relation to the team: I must help avoid friction, I must take responsibility, etc. They put high priority on the maintenance of harmony and on the avoidance of conflict. After the game, they were more concerned with action than with harmony. They were concerned about attitudes that the team had developed, about the effects of these attitudes on team performance, and about what they could do to change or control the behavior of others on the team.

With respect to challenges of maintaining their company's position, the post-game comments differed from pre-game comments mostly by reflecting a greater knowledge of how the game worked and by describing problems and challenges in more detail. There seemed to be a slight trend in the post-game comments toward more attention to problems of innovation—developing quantitative decision rules, reducing the amounts of routine analysis that have to be done, finding ways to be "more aggressive" with competitors, and seeking improved relationships with the boards of directors.

The sources of motivation and interest

We tried to assess students' motivation before and after the game by asking them to indicate on a five-point scale how likely they would be to participate in the game if it were voluntary rather than compulsory. In retrospect this may not have been a very good measure because it is not clear from the data that the players with the highest interest post-game worked any harder at the game or learned any more from it on the average than the less interested players.

Still, taking this measure of interest as one index of motivation, what affects interest levels of players in the game? First of all, as studies like Remitz's [18] suggest, much of the motivation to take part in something like a management game has little to do with experiences in the game. Initial expressions of interest tend to persist through the game. Table 5 shows that a higher proportion of students than we would expect by chance did not change their level of interest between the beginning and the end of play. Fewer than we would expect by chance made large shifts up or down on the interest scale.

A second hypothesis about the factors affecting interest says that motivation will depend on team performance. Table 6 shows that post-game interest ratings, averaged by teams, have a closer relation to the teams' profits than they do to pre-game interest ratings. Persistent experiences of failure, as one might expect, seem to be particularly damaging to interest in the game.

Neither of the hypotheses fully explains the wide variations in post-game

TABLE 5

Pre-Game to Post-Game Shifts in Interest Level (1961 Runs)

Point spread between pre-game & post-game answers	Number of students	
	Observed	Expected (equal chance, given initial distribution)
0	12	7.6
1	18	12.2
2	5	8.7
3	2	6.5
4	1	3.1

Results of chi-square test: p (Obs. same distribution as Exp.) < .01

TABLE 6

Pre-Game Interest, Post-Game Interest, and Profit Performance (1961 Runs)

Team	Mean pre-game interest	Mean post-game interest	Total profit (12 months—millions of dollars)
A1	3.5	3.8	$39.7
A2	4.0	3.0	18.8
A3	4.1	3.0	33.4
B1	4.2	3.9	67.5
B2	3.4	3.1	46.5
B3	4.5	4.0	71.6
		r = .23	r = .86

interest that show up among the individual players, though. Let us look further for links between interest and activities in the game. To the extent that experiences in the game do matter, is it the job that a man does which matters or is it the influence that is attributed to him by his teammates?

The answer seems clearly to be that job matters more than influence position. There is no relation between post-game interest ratings and post-game ratings of which men on each team were most and least influential. But it is clear from data gathered in both the 1960 and 1961 runs that while men going into different functional jobs had relatively homogeneous degrees of interest before the game, men in some jobs lost interest more rapidly than men in others did as the game progressed. After the game, presidents and marketing managers—the men with the most difficult and time consuming jobs—have consistently been happiest about their experiences. The finance, production, and research and development managers were next most satisfied. The controllers, operations research specialists, and executive vice-presidents were least satisfied. The least-satisfying jobs are so in part because within the context of the game they are regarded as routine and unchallenging—they offer the fewest opportunities to learn or to take actions that will affect the fortunes of the team.

Relation of learning to activities in the game and to prior experience

It is not clear from the limited range of our experience at Carnegie how learning in a game depends on the jobs that players perform, but it is clear that these relationships are very important and are worth further study. Each functional officer has his own set of tasks to perform. The president and two or three others on the team are likely to dominate interactions with the boards of directors, and the production manager and the president have the best opportunities to learn from negotiations with the union. The controllers in the 1961 game run found that their experience as auditors of the previous year's game teams was helpful in developing satisfactory systems of internal controls, but many others on the 1961 teams indicated that the audit experience had little or no effect on their game play.

The data of Tables 7 and 8, although of questionable reliability, suggest some of the differences in learning opportunities that different positions may afford. From Table 7, it seems that presidents, executive vice-presidents, and men in

TABLE 7

Aspects of Learning vs. Position in the Game: Amounts, Sources, and Levels of Learning (1961 Runs)

Position	Amount	Sources			Levels	
	No. of codings/man	Team Derived	Externally Derived	Model Derived	Problem Recognition	General & specific solutions
President & exec. vice-president (8 men)	3.4	63%	15%	22%	74%	26%
V-P, marketing (6 men)	3.8	87	9	4	61	39
V-P, production (5 men)	3.6	72	17	11	56	44
V-P, finance (6 men)	2.3	71	8	21	86	14
Controller (5 men)	2.2	100	0	0	73	27
Res. & dev. men & marketing ass'ts. (8 men)	2.8	73	18	9	64	36
Oper. research men & other ass'ts. (4 men)	2.0	80	10	10	50	50

TABLE 8

Aspects of Learning vs. Position in the Game: Importance Ascribed by Men to Specific Factors in the Game Environment (1960 Runs)

Position	Mean degree of importance ascribed (Scale: 0, low; 6, high)			
	15 Factors relevant to marketing	11 Factors relevant to production	2 Factors relevant to finance	9 Wholly irrelevant factors
President (5 men)	4.7	3.7	3.8	1.5
Marketing officers (8 men)	5.1	3.1	3.3	1.2
Production officers (5 men)	4.0	3.7	2.6	1.6
Finance officers (6 men)	4.3	3.0	2.9	1.0
Planners (5 men)	5.1	5.1	3.6	3.0

charge of marketing and production learn more than men in other positions do. Table 8 (based on data from the previous year 1960) confirms this impression. On a list of "factors" in the game environment, the principal officers of teams were better able to recognize the differences in importance between relevant and irrelevant "factors" than the planners (mostly marginal team members) were. Tables 7 and 8 also suggest differences among positions in the sources, levels, and focus of learning.

What players learn also seems to depend greatly on the experience and attitudes which they bring to the game. Trial runs show that for sophomores with little or no knowledge of business, it is a major task to read the information which they have to work with and to comprehend the basic dimensions of the decision problems that they face. With executives from industry who think they know how to manage firms, there is likely to be less experimentation with strategies and more consistent effort to maintain strategies which they are convinced are good.

III. Problems of Studying Learning in the Game

Our use of the Carnegie game has been less as an environment for teaching than as an environment for self-instruction. Learning in the game is very much akin to learning from day-by-day experience in real life.

Learning in ambiguous, complex situations like the game has not received much formal attention from behavioral scientists. Psychologists usually focus on simpler processes: on changes in behavior or in the cognitive structures that govern behavior after exposure to a relatively simple stimulus or series of stimuli and to unambiguous patterns of reinforcement. The environment is one which the experimenter has created and which he controls. He is the only source of inputs to the individual or group. The experimenter can be reasonably sure that what he intends as a stimulus, an opportunity to act, or a reward will be attended to and will be seen as he has designed it to be seen. He knows what can be learned; and by appropriate design of the setting and the task, he can make most of his subjects' prior knowledge and experience irrelevant.

In the game or in real life, things are not as simple. Players in the game deal with stimuli from many sources, with quite variable relevance to the goals the players and the game administrators have set. Even in the case of stimuli intended by the game's designers and administrators to pose particular problems, there is no direct link between stimulus and action. Much of the information that players have access to they never pay attention to. Teams use their past experience, their goals, and simple associative rules for tying information together to restructure the things that they see and hear into definitions of tasks to be performed. And when they take action, there is no clear external reaction or reinforcement to the response. One of the major challenges of the game in fact, is to discover what results actions of various kinds do bring. Reinforcement—or what teams perceive as reinforcement—comes from many sources, and it may not always be what the game designers or administrators intend.

Ideas about socialization and enculturation, put forth by sociologists and anthropologists, come closer than many psychological theories of learning to describing the process of acquiring experience. Socialization is the total series of activities and interactions through which a child becomes an adjusted adult member of society. Enculturation, as used by Avery [1] to describe the adaptation of newly trained engineers and scientists to careers in industrial laboratories, is closer to what we are talking about; but it refers mainly to adaptation and learning in the sense of acquiring new values and working out new kinds of interpersonal relationships. It does not refer to learning new technical knowledge or professional skills.

For our purposes in describing learning in a management game, concepts of socialization and enculturation put too much emphasis on the long-run and are too exclusively concerned with learning that occurs in interactions with other people. The analysis of learning from experience is not primarily long-run in nature and not exclusively concerned with learning of inter-personal relations. It looks instead at how exposure to certain kinds of environments changes the knowledge, the attitudes, and the skills that people store away as guides for their subsequent behavior.

To understand better how people learn from experience in a management game, we need a different framework of analysis than basic psychological learning theory or theories of socialization offer. The former is useful for its attention to the effects of patterns of reinforcement on learning, and the latter is useful for its attention to the importance of social interactions in human learning and development. The key elements missing from both theories are cognitive ones. To understand how hypotheses about reinforcement or social interaction might apply to learning in a game, we need first to be able to outline:

1. The processes by which players attend to their environment and translate the inputs of information that the environment presents into tasks for themselves to perform.
2. The ways in which players discover and conceptualize alternative ways of completing tasks and make choices among them.
3. The ways in which players use information from their environment and assumptions from prior experience to define "outcomes" or "consequences" of the actions they have taken.
4. The value systems by which outcomes are interpreted to become sources of satisfaction or dissatisfaction for the players and to reinforce or extinguish existing patterns of behavior.

This involves more intensive study than we have done so far of the goals, the expectations, and the action habits which players bring with them into the game. It involves more analysis not only of the kinds of information that players pay attention to, but of the sources of information they attend to and of their heuristics for putting isolated pieces of information together. Since in a complex environment, players can only attend to a small part of the information that is available to them, different patterns of selection will lead to different perceptions of tasks, different definitions of action alternatives, different attributions of consequences, and perhaps even different development of systems of values.

Both because of the complexity of the processes we need to study and because of difficulties in arranging and running adequately controlled experiments, even to test simple hypotheses, we doubt that many of the questions we have about the educational effectiveness of games can be answered by the kinds of comparative studies that have figured promimently in efforts to evaluate teaching methods.

A proposed strategy, from this point on, would be to try to detect changes in behavior that occur during play of the game; to try by observation, interviews and questionnaires to determine how these changes took place; and then by inserting constraints on team behavior in future runs of the game or by developing simulations of teams' learning processes, to try to evaluate our hypotheses.

Unless there are ways to induce players to make their learning explicit, it will always be difficult to assess what games accomplish. Ideally, a long-range study should include an effort to find in later courses or job activities aspects of behavior that have been affected by game experience.

IV. Conclusion

The faculty at Carnegie is persuaded that a complex management simulation exercise is a valuable addition to graduate and post-graduate training programs. The evidence of learning that we have tried to summarize here and that we have reported in other papers [4, 6, 7, and 14] is far from conclusive, but it has been more persuasive than the limited evidence that is available on the value of competing methods for giving students experience with the problems of top management. It has been persuasive enough to convince skeptics on the Carnegie faculty that the game was worth the cost of developing and debugging it, to make it the first of several innovations in curriculum that the faculty accepted when we last revised the graduate program, and to keep three-fourths of the faculty and several outside business executives willing to commit 20–40 hours apiece to serve as directors or union negotiators during a semester's game play.

We hope that this limited exploration of what students learn and how they learn from experience in a game has defined more clearly the problems which we face in future research and has called attention to the need for new kinds of game structure, incentives, and feedback arrangements to make game experiences richer for all participants. This implies a particular effort to get better balance between the access the men in different positions on a game team have to learning opportunities in the game and an effort to add for all men activities of a reflective nature that may help them solidify and extend the things they are learning within the game to problems that they will face in other settings.

To capitalize on the real educational potential of management games, we need to consider more explicitly questions of *how* people learn when we design games and plan their use. Further studies of what happens to students in games are needed, both of the cross-sectional type undertaken by McKenney and Robinson and of a more intensive longitudinal nature. The latter should focus more on the development of knowledge, strategies, and attitudes in individual students—trying to assess in detail the effect of previous experience on their

style of play, the changes and developments that occur in the game, and the kinds of changes that the game brings in later behavior.

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