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ABSTRACT

Backtrack problem-solving appears to be a viable alternative to current problem-solving methodologies. It appears to have considerable heuristic potential as a conceptual and operational framework for small group communication research, as well as functional utility for the student group in the small group class or the management team in the private organization. The method's major advantages are: (1) problem-solving processes are conceptualized and operationalized as a network of interdependent components influencing all relevant outcomes, (2) it can be used efficiently in most problem-solving situations, and (3) it is concerned with more than the identification and description of task-oriented or problem-solving behaviors. (EE)

Backtrack Programming: A Computer - Based Approach To Group Problem Solving

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For the most part, group problem solving perspectiv e have focused on procedures of problem solving behavior rather than on substantive issues such as criteria for optimization and the number and quality of solution alternatives. This emphasis on the procedural aspects of problem solving patterns has led to few knowledge claims concerning the effects of pattern on the final product of group problem solving behavior (e.g., Brilhart, 1966; Bayless, 1967). In fact, it has been argued that the problem solving pattern per se may be a relative unimportant variable for groups engaged in decision-making processes. When considering current problem solving methodologies this conclusion seems warranted. Modification of Dewey's reflective thinking model does little more than provide group members with independent steps in decision-making and these are prescriptive at best. PERT analyses are best suited to complex managerial problems in large organizations and even then its solutions have been demonstrated to be only as good as those generated by the most experienced members of the management team (Carlsmith, 1972). Fishers model for decision-making in small groups (1971) is complete in its discussion of phases in decision emergence but is primarily concerned with the identification and description of behavioral phenomena in these phases.

The intent of this paper, consequently, is three-fold. First, popular models of problem solving are considered. Second, Backtrack Programming (Golomb and Baumert, 1965), a cybernetic model of search and decision-making that is isomorphic with problem solving behavioral models of small group communication, is explicated. And, third, the program is justified as a functional alternative to less systemic problem solving methodologies currently employed in small group communication research.

Popular Models of Problem Solving

In the broadest sense, then, there are three major types of problem solving or decision making models that have received extensive use in small group communication research. Characteristic of the first type, which for purposes of this paper we will arbitrarily call cognitive models, are Dewey's process of reflective thinking (1938) and ideation-criteria models (Osborn, 1957; Parners, 1962; Brilhart and Jochem, 1964).

Dewey's model is concerned with the analytic capabilities of the individual as applied to group functioning. As noted earlier, it is also a prescriptive model supplying group members with independent steps to follow during the course of decision-making. There are a number of major deficiencies that can be advanced against this method. To begin with, there is little empirical evidence that supports the pattern as an effective device for group problem solving behavior (Bayless, 1967). Second, it attempts to substitute an individual process for group process (Kelley and Thibaut, 1954) and, third, it belies the fact that phases in problem solving are interdependent rather than independent (Fisher, 1971).

On the other hand, there is some evidence suggesting that ideation-criteria models positively effect dependent variables associated with group outcomes (e.g., number of possible solutions, number of "good" ideas). Unfortunately, however, this approach has primarily focused on the creative problem solving group rather than the task-oriented decision-making group, and much like reflective thinking, views ideation and criteria almost as separate entities.

A second major type of problem solving model focuses on the emergence of task behaviors during problem solving or decision-making. Bales and Stodtbeck's three phase progression of group development (1956) and Fisher's model (1971) for phases in decision emergence are generally representative examples of this type. Most common among criticisms of the Bales and Stodtbeck model of phase progression is its lack of focus on interaction processes relating to specific task behaviors which seems crucial to communication research. Thus, while the model is accurate in its initial descriptions of group problem solving behaviors (Fisher, 1970), it is somewhat vacuous in terms of communicative task behaviors relating to problem solving.

In contrast, Fisher's model is particularly concerned with "the nature of the interaction process across time to group concensus on decision making tasks" (1970, p. 54). In addition, it is certainly complete in its discussion of how interaction across time influences task behaviors during specific periods (i.e., phases) of problem solving. What the present authors find bothersome, however, is the models limited utility outside the context of communication research. Our major criticism of this type of model, consequently, is that its prescriptions, for the most part, apply to the researcher and not the actual problem solver. In short, we perceive the heuristic and functional utility of problem solving models not as mutually exclusive but as mutually interdependent.

The final type of model to be reviewed, then, stems from general systems design and analysis which has shown promise in regard to the preceding concerns. It is curious to note, however, that communication researchers have typically selected PERT (i.e., program evaluation and review technique) from the available systems programs as that most applicable to the small group communication paradigm. The present authors couldn't disagree more. To begin with, PERT was designed to manage problems that are immensely complex involving large monetary amounts, thousands of man-hours, and vast amounts of material goods. Such problems seem hardly analagous to the kinds of problems that commonly confront the small group problem solver. More importantly, though, while PERT has been demonstrated to be effective when applied to large, complex problems, it has also been demonstrated to be grossly inefficient in terms of man-hours and dollars when applied to small groups of individuals responsible for relatively rapid decision-making (Carlsmith, 1972).

This brings us, consequently, to the operation of Backtrack Programming as a model for small group communication problem solving. It should be noted from the outset, that we are not offering the approach as a cure-all for the maladies noted in the preceding page but as a methodology that might be integrated with the more positive characteristics of the models that have preceded it.

Specifically, Backtrack Programming is one of a number of methods developed in the computer sciences to determine the most optimal or expedient solution to a problem characterized by combinational explosion. Combinational explosion simply means that there are a large number (e.g., 100 or 1,000) of finite solutions to the same problem that are unique or independent of each other. Depending on some external criterion, of course, some of these solutions are more optimal than others and it is one of these that we wish to determine vis-a-vis the backtrack process. Stated another way, Backtrack is designed to yield the most optimal solution to the multifarious problem without exhausting all of the possible combinations in existence; that is, depending on the criterion established which works much like an a priori level of statistical confidence. There are two major assumptions in this regard. First, Backtrack assumes that a solution exists, and second, it assumes that all of the possible solutions are independent of each other. Given this framework it is now possible to examine the basic formulations of the program.

Pre-Problem Solving Activity

To begin with, Backtrack Programming is best suited to problems that can be further reduced to subproblems. If, for example, the major problem concerned sixth grade reading levels it would seem reasonable to assume that a number of independent subproblems might also be relevant to an optimal solution following problem solving behavior. Thus, Backtrack requires that its user attempt to exhaust the independent subproblems (e.g., X_1, X_2, X_3, X_4, ... X_n) that exist prior to the actual problem solving. Second, the program is similar to an open system (Bertanlaffy, 1955) in that it requires those using it to formalize the major and subproblems or start state (S$\emptyset$ (to)) in light of the desired state (S$\emptyset$ (to + t)). In other words, it forces the users to consider the problem first, in terms of what the problem solving activity is designed to accomplish. Finally, Backtrack demands that the problem solvers establish some criterion or criteria ($\emptyset$) which determines whether or not a possible solution (e.g., x_I, x_{II}, x_{III} . . . . x_n) generated by a group member is accepted or rejected. This is tantamount since the more rigid the criterion or criteria the greater the probability that the solution will be optimal. Backtrack, consequently, is distinctly more systemic than the preceding models in the sense that it thoroughly orients the problem solver to the sequential aspects of the problem solving activity. Furthermore, none of the above steps can be thought of as independent from one another. In short, each step affects the other which, in turn, influences the optimality of any decision that the group makes.

<u>Problem Solving Activity</u>

In terms of actual problem solving, then, Backtrack programming is, by design, inflexible and deliberate. First, it requires that members of the problem solving group approach each subproblem in hierarchical fashion. That is, it requires the group to examine subproblem X_1 first, X_2 second, X_3 . . . . to X_n depending upon the number of subproblems that exist. Following the selection of the first subproblem the group members can begin to generate solutions until one meeting the a priori criterion function ø is found. At this point, the problem solvers select the second subproblem and repeat the process. This procedure is followed, consequently, until the major problem is solved or it is determined that none of the solutions generated for a particular subproblem meet the criterion (or one of the criteria) established prior to problem solving activity. If this is, in fact, the case, Backtracking to the preceding subproblem (e.g., X_4) is warranted. This is done because the solution generated for subproblem X_4, while meeting the criterion function, may have been suboptimal and therefore precluded the possibility of finding a satisfactory solution to the subproblem X_5 immediately following it. If this isn't the case, the problem solvers would continue to Backtrack (e.g., X_3, X_4) until the suboptimal solution was found. Once this is accomplished more optimal solutions for all of the subproblems should follow. (Figure one depicts the Backtrack process and the basic functioning of the Backtrack algorithm.)

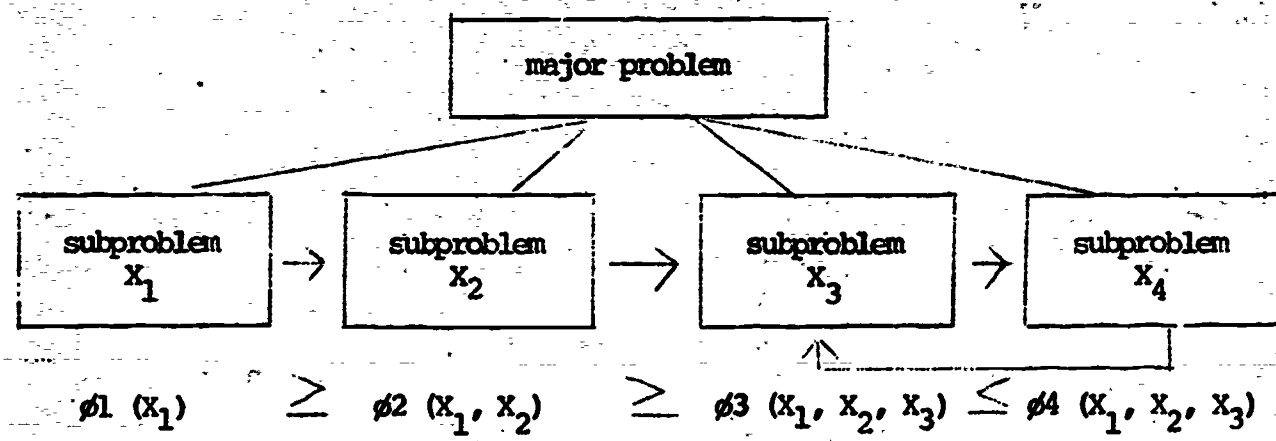

Figure 1

Essentially, then, Backtrack is designed to coerce its user to approach the problem from a systematic conceptual and operational framework. In addition, it attempts to structure the problem solving situation to such a degree that problem solvers can't possibly ignore criteria for optimization or the number and quality of solution alternatives that they can generate. Stated another way, the program stresses the need for problem solvers to realize that what appears a workable solution to a specific problem is not necessarily the only solution or that which is most optimal. Given the preceding framework, Backtrack Programming has considerable import to both small group communication researchers and small group problem solvers. In fact, it appears to have particular significance to research concerning variables that are relevant to task-oriented or decision making behaviors such as concensus, effectiveness of decision, satisfaction with decision, and cohesion. For a more detailed analysis of the Backtrack algorithm see Golomb and Baumert, 1965. First, the program is wholly amenable to the systematic study of these variables. More specifically, its conceptual and operational framework thoroughly patterns the phases in group functioning when task or decision making behaviors will have some direct influence on one or more of the above variables. Criteria for concensus, for example, is built into the operation of the program as well as criteria for optimality or effectiveness of decision. The program, in fact, is infinitely superior in this regard to the models reviewed earlier in the analysis. In addition, intuitive if not empirical grounds, suggest that concensus and optimality of decision are strongly related to satisfaction with decision and cohesion. Thus, it would appear that the program might be effectively used for research designed to specifically assess whether or not such a conclusion is warranted.

Also, Backtrack Programming, much like Fisher's model, seems susceptible to research designed to assess interaction across time.* This conclusion is based on the fact that each attempt at providing a solution to one of the subproblems can be thought of as a unit of problem solving activity or interaction. For example, 10 subproblems could be viewed as 10 units of problem solving interaction. In the case that backtracking is warranted these units could be further divided (e.g., unit 1a = problem solving activity during the first solution stage concerning subproblem X_1, unit 1b = problem solving activity following the discovery that the first solution was suboptimal; precluding an optimal solution to subproblem X_2). As a consequence, the researcher could systematically observe "group process" as it relates to problem solving behaviors.

In contrast to the models of Bales and Stodtbeck (1956) and that of Fisher (1971), however, Backtrack can also be used by problem solvers as a methodology for optimal problem solving activity. In effect, this is the programs primary purpose. That is, Backtrack Programming is specifically designed to maximize the probability that decision-making activities are not only systemic, but that they also yield decisions or solutions that approach some a priori level of optimality.

Therefore, Backtrack problem solving appears to be a viable alternative to current problem solving methodologies. Moreover, it appears to have considerable heuristic potential as a conceptual and operational framework for small group communication research, as well as functional utility for the student group in the small group class or the management team in the private organization. The programs major advantages appear to be 1) problem solving processes are conceptualized and operationalized as a network of interdependent components influencing all relevant outcomes, 2) it can be used efficiently in most problem solving situations, and 3) it is concerned with more than the identification and description of task oriented or problem solving behaviors. As a result, the present authors are currently engaged in research designed to assess its applicability in a number of small group communication research paradigms.

*Gouran recently posited (1973, p. 24) that these variables are central to any theoretic payoff in small group research.

References

Bales, R. F., and Stodtbeck, F. "Phases in group problem-solving," J. abnorm. soc. Psychol., 46 (1951).

Bayless, O. L. "An alternate pattern for problem-solving discussion," J. Comm., 3 (1967).

Bertanlaffy, L. V. "General systems theory," Main Currents in Modern Thought, 2 (1955).

Brilhart, J. K., and Jochem, L. M. "Effects of different patterns on outcomes of problem-solving discussion," J. appl. Psychol., 48 (1964).

Dewey, J. How We Think, Boston: Heath, (1910).

Fisher, B. A. "Decision emergence: phases in group decision making," SM, 37 (1970).

________ "Communication research and the task oriented group," J. Comm. 21, (1971).

Golomb, S. W. and Baumert, L. "Backtrack programming," J. assoc. Compt. Mach., 12 (1965).

Gouran, D. "Group communication: perspectives and priorities for future research," QJS, 59 (1973).

Kelley, H., and Thibaut, J. "Experimental studies of group problem solving and process," Handbook of Social Psychology, ed. Gardner Lindzy, Reading: Addison-Wesley (1954).

Osborn, A. Applied imagination, New York: Scribners (1957).

Parnes, S. J. "The creative problem solving course and institute at the University of Buffalo." ed. S. J. Parnes and H. F. Harding, A Source Book for Creative Thinking. New York: Scribner's Sons (1962).