Chapter One

BASIC CONCEPTS IN GROUP PROBLEM SOLVING

In the most general sense, a problem is a discrepancy between a current less desirable state and a future more desirable state. The current state may be a simple question such as "Who was the first President of the United States" and the desired state the answer "George Washington." The current state may be the diameter of a circle and the desired state the circumference of the circle. The current state may be a set of clues in a crossword puzzle and the desired state the correct answers. The current state may be a new deadly contagious disease and the desired state an understanding of the etiology, vectors, treatment, and prevention of the disease.

Although problems vary widely in domain (scientific, engineering, business and financial, artistic and literary, etc.), complexity (simple or complicated), specification (well defined or poorly defined), and relationship to other problems in a larger system, all problems involve proceeding by a series of permissible logical, mathematical, scientific, physical, or linguistic operations from the current less desirable state to the future more desirable state. Scientific research teams, auditing teams, grand juries, criminal and civil juries, university hiring committees, school boards, weather forecasters, the Council of Economic Advisors, and forensic art experts are some of the many groups who attempt to solve problems in our increasingly complex and interdependent world.

Group Task, Structure, Process, and Product

Group problem solving may be analyzed in terms of four basic constructs: (a) group task, (b) group structure, (c) group process, and (d) group product. The group *task* is what the group is attempting to do. *Group structure* is the organization of the group, including (a) *roles*, the different positions within the group, (b) *norms*, the expected beliefs and behaviors for the group members, and (c) *member characteristics*, the demographic, physical, and psychological attributes of each group member. *Group process* is how the group members interact with and influence one another. *Group product* is the collective group response or output. The correspondence of the product to the objective of the group defines

success or failure and determines the rewards or punishments for the group members. In *cooperative interaction* such as group problem solving all group members have the same goal or objective and share equally in the rewards and punishments. In *mixed-motive* interaction such as social dilemmas the group members have different objectives, and the rewards and punishments vary for the different group members.

To illustrate these four constructs consider the Supreme Court of the United States. After accepting a case in the certiorari process the group task is to issue a decision with an accompanying explanation. The structure of the Court consists of the roles of Chief Justice and eight Associate Justices, all of whom serve for life unless impeached and convicted by Congress. Member characteristics are the demographic attributes and experience of each Justice such as age and gender, college and law school, and Appellate Court positions, and their knowledge, beliefs, attitudes, and values. The Court follows norms such as sitting in seniority order when the Court is hearing a case. The Chief Justice may assign other norms such as speaking in turn in seniority order without interruption during conference meetings.

After a decision to accept a case the first part of the group process involves hearing the case in open session in the Supreme Court Building, when advocates of the two parties in the case present their oral arguments and answer questions from the Justices. The Justices subsequently discuss the case in private and make a preliminary group decision by a formal vote with a simple 5/9 majority rule. If the Chief Justice is in the majority faction, he or she writes the opinion or assigns it to one of the other Associate Justices in the majority faction to write the opinion of the Court. If the Chief Justice is in the minority faction, the most senior Associate Justice in the majority faction assigns the case to one of the Associate Justices in the majority faction to write the opinion of the Court. The written opinion is then circulated among the Justices, who may respond in written agreements or dissents and suggested changes. They may discuss them with one or more other Justices. Each Justice has three or four Clerks who are also involved in writing and vetting the opinions. Subsequently the Justices meet in private for a final decision by a formal vote with a 5/9 simple majority rule.

The final group product is a Supreme Court Decision with the accompanying written majority opinion, perhaps with further statements by both the concurring Justices and the dissenting Justices explaining their individual reasoning. Greenburg (2007) and Toobin (2007) present informative and interesting accounts of the individual Justices, procedures, policies, decisions, and controversies of competing interest groups and congressional parties in the Supreme Court under Chief Justices Rehnquist and Roberts. Amar (2005) presents a comprehensive history of the U.S. Constitution and the steadily increasing importance of the

Supreme Court in interpreting the Constitution and the constitutionality of federal and state laws.

Interpersonal Influence Processes

In a classic chapter French and Raven (1969) distinguished five types of interpersonal influence processes, or power. *Reward power* is the capacity of the group members to provide desirable experiences and outcomes for one another, whereas *coercive power* is the capacity of the group members to provide undesirable experiences and outcomes for one another. In the Supreme Court the Chief Justice assigns opinions to the other Justices, and thus is able to reward or punish them by the number and desirability of assignments. *Expert power* derives from specialized knowledge and abilities, training, and experience. On the Supreme Court the Justices vary in their knowledge and experience in specific areas of the law and past constitutional history, and hence have corresponding expert power over the other Justices. *Legitimate power* derives from a formal system that is accepted by the group members and the larger society. The legitimate power of the Justices to determine the meaning of the law and decide cases follows from their nomination by the President and approval by the Senate. Finally, *referent power* derives from identification with a respected person or institution. The Justices typically identify strongly with one another and with the Supreme Court as an institution, although they may not agree on judicial philosophy, values, or particular cases (Greenburg 2007).

More generally, these five types of interpersonal influence or power may be aggregated as *informational influence* and *normative influence* (Deutsch and Gerard 1955). In *informational influence* group members influence one another by information about people, abstract systems, and world knowledge. In *normative influence* group members influence one another by rewards, punishments, norms, and values. Basically informational influence concerns matters of truth, and normative influence concerns matters of value. The long history of theories of attitudes in social psychology may be considered attempts to integrate matters of truth and matters of value in the single construct of attitude (Eagly and Chaikin 1993; McGuire 1969, 1985).

Group Tasks

Additive, Compensatory, Conjunctive, Disjunctive, and Complementary

In a seminal article Steiner (1966) proposed five types of group tasks. *Additive* tasks are situations in which all group members perform

individually and the group product is the sum of the member products. For example, a number of employees in a large office may each independently process applications for credit cards without interacting with one another. The group product is the sum of the applications processed individually by each of the employees. On *compensatory* tasks all group members estimate some current or future quantity or event, without any group interaction, and the group product is the mean or median of the individual estimates. For example, a number of stockbrokers may estimate the value of the Dow Jones Industrial Index one year in the future, and the group product is computed as the mean of their individual estimations. The best-selling book *The Wisdom of Crowds* (Surowiecki 2004) gives many examples of compensatory tasks.

In contrast to additive and compensatory tasks, where the group members do not interact with one another, on conjunctive, disjunctive, and complementary tasks the group members interact with one another and influence one another to produce a group product. On a *conjunctive* group task all group members must succeed in order for the group to succeed. Examples include a group of mountain climbers roped together, where a single member who falls will bring disaster to all, or a rowing team, where a single member who "pulls a crab" will result in group failure. On a *disjunctive* group task, the group will succeed if a single group member succeeds. An example is a small group of high school students working on an algebra problem, where one group member who knows the correct answer persuades the others to accept it as the group response. Conjunctive and disjunctive tasks are thus the end points of a continuum of the number of group members who must succeed for the group to succeed. Other group tasks require that fewer than all group members or more than one member must succeed for group success. For example, in a cross-country meet each team may enter seven runners, but only the first five finishers count for the team score.

A *complementary* group task allows the group members to combine different abilities, skills, knowledge, or other physical and cognitive resources in a collective product that is more than any group member could produce alone. Examples include coordinated group tasks such as a football team running a play or an orchestra performing a symphony. A scientific research team typically consists of members with different knowledge, skills, and abilities that are combined to conduct scientific experiments that none of the members could produce alone. Complementary tasks correspond to the maxim of Gestalt psychology that "the whole is greater than the sum of its parts" or the aphorism of Benjamin Franklin that "the good men may do separately is small compared with what they may do collectively" (Isaacson 2003).

Divisible and Unitary

Steiner (1972) subsequently published an influential book titled *Group Process and Productivity* that added other considerations. *Divisible* group tasks can be divided into subtasks and assigned to group members, whereas *unitary* group tasks cannot meaningfully or efficiently be divided into subtasks and assigned to different group members. For example, two people can each type different parts of a manuscript at the same time on different terminals, but they cannot efficiently type one manuscript on the same keyboard of one terminal (say, by each person typing every other letter).

Maximizing and Optimizing

Steiner (1972) further distinguished maximizing and optimizing group tasks. *Maximizing* tasks have physical criteria such as quantity, distance, or time. For example, the criterion of performance in pushing a stalled car to the edge of the highway is moving the car as fast as possible. The criterion of performance in a 400-meter relay is time. In general, there are objective criteria for maximizing tasks and typically little argument within the accuracy of measurement. In brainstorming tasks the objective is to produce as many ideas as possible rather than to produce good ideas (Diehl and Strobe 1987, 1991). *Optimizing* tasks do not have objective criteria of performance but instead are judgments of the quality of performance. For example, the criterion of success in mixed-pairs figure skating is technical performance and artistic impression rather than the physical criteria of speed or the lifted partner's weight. The criteria of performance for a college term paper are not total words but comprehensiveness, accuracy, persuasive organization, creativity, and so forth. The criterion of performance for a string quartet is not to play as fast or slow, loud or soft, as possible, but to meet standards of quality, coordination, and musicality. In general, optimizing tasks require subjective judgments of raters, evaluators, or judges on standards of quality rather than objective measurement. Because the criterion of success on optimizing tasks is subjective judgment rather than objective physical measurement, the raters, evaluators, or judges may disagree in their evaluations.

Intellective and Judgmental

Laughlin (1980) proposed a group task continuum anchored by intellective and judgmental tasks. Intellective tasks have a demonstrably correct solution within a mathematical, logical, scientific, or verbal conceptual system. For example, high school geometry problems have a definite

correct solution within the axioms, postulates, definitions, and proofs of Euclidean geometry. A correct answer or proof can be demonstrated to anyone who accepts Euclidean geometry and can understand the proof. Most college physics, chemistry, and biology problems have a definite correct solution within the respective scientific systems. English vocabulary problems have a definite correct answer within the system of the English language. Some questions about the political system of the United States have a definite correct answer within the Constitution, such as the minimum age of thirty-five for the U.S. President.

In contrast, *judgmental* tasks are evaluative, behavioral, or aesthetic judgments for which no generally accepted demonstrably correct answer exists. For example, attitudes are evaluative judgments that something is good or bad, appropriate or inappropriate, attractive or unattractive. A person who is against capital punishment cannot readily demonstrate that this attitude is correct to a person who favors capital punishment, and vice versa. A person who likes a Mozart concerto, Titian portrait, Dusenberg touring car, and Brie cheese cannot demonstrate that these preferences are correct to a person who likes a Beethoven concerto, Rembrandt portrait, Packard touring car, and Limburger cheese, and vice versa. In contrast to groups facing problems with a definite correct answer, many groups face judgmental rather than intellective tasks, for example, bankers deciding on a loan, juries deciding on guilt or innocence in criminal cases, or faculty hiring committees deciding on a job candidate.

Laughlin and Ellis (1986) subsequently proposed that demonstrably correct solutions require four conditions. First, the group members must agree on a mathematical, scientific, logical, or verbal conceptual system. Second, there must be sufficient information to solve the problem. For example, there is sufficient information for a unique solution for x in a simple linear algebraic equation with one unknown such as "$x + 3 = 13$" but insufficient information for a unique solution for x and y in an equation with two unknowns such as "$x + y = 13$." Third, the group members who do not know the correct answer must have sufficient knowledge of the system to recognize the correct answer if it is proposed by one or more group members. Fourth, the correct member or members must have sufficient ability, motivation, and time to demonstrate the correct answer to the incorrect member or members.

Summary

Group problem solving involves complementary, divisible, optimizing, intellective tasks for which a demonstrably correct answer exists within a conceptual system. The objective for the group is to achieve this correct answer, in contrast to group decision making on judgmental tasks

without demonstrably correct answers where the objective for the group is to achieve consensus.

Laboratory Experimental Research on Group Problem Solving

The research considered in this book is based on laboratory experimental studies. Laboratory experimental research allows random assignment of participants to manipulated experimental conditions (independent variables) and systematic measurement of the results (dependent variables). Laboratory experimental research entails the power and logic of the scientific method: formulation of hypotheses from observation and existing theory, manipulation of two or more conditions (independent variables); controlled and replicable measurement of the results (dependent variables), accepted methods of analysis; and accepted criteria for interpretation and generalization of the results.

Controlled laboratory experimental research is an abstraction from more complex phenomena, and the research considered in the following chapters has typically used relatively simple problems and readily available participants such as college students in the search for basic principles that may apply to more complex problems and other populations.

Overview of Chapters

Chapter 2 considers the historical development of social combination models, which are then assessed on different types of group tasks in many of the studies in the subsequent chapters. Chapter 3 considers research on group memory, which is important in itself and is also frequently a necessary preliminary process for further group problem solving. Chapter 4 considers group ability composition and social combination processes on world knowledge tasks. Chapter 5 considers collective induction, the cooperative search for descriptive, predictive, and explanatory generalizations, rules, and principles. Chapter 6 considers letters-to-numbers problems, an interesting class of problems that entail many insightful strategies. Chapter 7 considers group-to-individual problem-solving transfer, the effect of experience in cooperative group problem solving on subsequent individual problem solving by the group members. Chapter 8 considers social choice theory, an axiomatic and deductive approach to societal problem solving by existing or possible voting procedures. Chapter 9, the concluding chapter, proposes generalizations that emerge from theory and research on group problem solving and a brief retrospective and prospective.