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Mutual Gains From Team Learning: A Guided Design Classroom Exercise

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ABSTRACT

Proponents of classroom- and team-based exercises argue that structured group problem-solving activities enhance student learning. A team-based, guided design exercise conducted annually from 1985-2002 supports the claim that most teams reach superior decisions than individual students left to their own knowledge. However, a very small percentage of teams were not successful reaching a learning goal and an equally small number of highly competent individuals found themselves worse off, in terms of a team versus individual solution, after a team exercise. Nevertheless, the overall evidence validates the team-based approach to problem solving as a useful active learning strategy in the classroom.

Key Words: team learning, guided design, teaching strategy, serial decision making

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Motivation

Alumni and employer surveys often reveal that employers of undergraduate students value problem-solving skills and the ability to work in teams more highly than other core quantitative training received in our agricultural, applied, and resource economics departments. Litzenberg and Schneider reported that interpersonal work skills such as self-motivation, a positive work attitude, high ethical standards and the ability to work as a team player clearly dominate hiring decisions, at least in industry. Recent hires in both private and public sectors report to their departments that they soon find themselves in their new careers solving organizational problems or responding to competitive challenges in teams, task forces, and committees on nearly a daily basis. Both employers and employees perceive that productive citizenship and the creation of social capital in teams represent important organizational priorities and values (Bolino, Turnley and Bloodgood). This recognition of the importance of learning in collaboration with fellow employees has spawned the emerging literature on action learning in business organizations (Dotlich and Noel, Redding, McGill and Beaty).

Contrasting didactic approaches in managerial economics classrooms, particularly those settings that supply both economic theory and management education, provide students with two sets of problem solving/decision-making tools. Standard microeconomic theory provides a valuable analytical framework for the study of decisions under constraints where a combination of postulates and assumptions combine to predict behavior or choices (Silberberg). Firm-level models to solve economic problems generally require specific knowledge concerning objective functions, technology, prices and their functional (generally mathematical or statistical) interactions and relationships. The instructor generally gives these data to students in the classroom and the individual learner solves the assigned problems.

In contrast, management—the process of allocating resources to reach a goal—is defined variably in the business literature as either a set of functions (George and Jones), tasks (Drucker), or as a process (Kepner and Tregoe). All three management frameworks capture the essence of a behavioral process of human interaction to reach organizational goals through data acquisition, analysis and decision implementation. Management broadly defines problem solving as a process whereas in economics solving problems involves more well-defined theory and precise quantitative methods. Human interaction within the firm, largely ignored in managerial economics except for the interdependent utility literature, is the central component in the decision making process in this management literature. Management theorists recognize, however, that the give and take of decision-making within organizations may or may not produce optimal economic outcomes because time and informational constraints place cognitive boundaries around the decision maker's choice set (Simon, Cyert and March). This management literature emphasizes explanation and description rather than prediction.

The process framework of management emphasizes a step-by-step procedure (e.g. goal definition, problem statement, information gathering, analysis, synthesis, decision, implementation, evaluation) of decision-making. This process is often labeled serial decision-making (SDM) because of the recommended sequential steps in organizational deliberations. The organizational benefits of SDM have been documented over the years with management testimonies, case studies, and organizational research as empirical support (Wales and Stager, Kepner and Tregoe, Altier, Lyles). Table 1 presents four versions of SDM in decision-making. All four sets of guidelines recommend problem or objective definition, evaluation and analysis of alternatives, and implementation/evaluation for reaching desired goals. Failure to follow the prescribed sequence of decision steps may produce either no decision or a sub-optimal one, a solution to the wrong problem, or general decision-making inefficiency characterized by a misallocation of time and money.

Stevens notes that several common human conditions block the best-intentioned efforts to reach a solution to a problem via SDM: perceptual biases, emotional attachments, knowledge and information limitations, communication challenges, external distractions and cultural predispositions. Team-based decision making can be a “monster or a miracle,” according to Leavitt and Bahrami. The “monster” obstacles to group SDM are intragroup competition or conformity, lack of leadership, and time constraints while “miracles” can happen due to greater expertise, mitigated biases, greater willingness to take risks, sense of community, and better decisions.

Little empirical evidence exists that measures the actual gains (if any) associated with SDM or with teams. Just how significant are the gains to teams and individual team members from joint problem solving processes? What factors in the process produce these gains to the organization? This brief note reports a test of the efficacy of team-based decision-making in comparison with individual non-sequential decision-making. In addition, this note correlates crude measures of team makeup (e.g. size, overall knowledge, variability, presence of experts, and relative individual knowledge) with the percent improvement in individual decisions when teams solve the same problem. Finally, I challenge my colleagues and myself to bridge the didactic gap between conventional economic and management problem solving in our classes by taking periodic advantage of the potential mutual gains associated with team learning.

The Exercise

A guided-design SDM exercise was conducted in a senior- and graduate-level managerial finance course from 1985-2002. Guided design is a learning strategy that directs students, working in small teams, to resolve open-ended problems (Wales and Stager). The facilitator guides the learners through the problem by periodic feedback (written or verbal), giving the team members a "slow-motion" experience as they develop their team's solution to the problem. The current reincarnation of guided design is action learning where, under the structured guidance of a facilitator, students participate in learning-by-doing case studies.

Two hundred and eighty students interacting on 62 teams participated in the SDM exercise. The identical problem assigned to all students was the classic Robinson Crusoe or shipwreck scenario where the stranded individuals must make a group decision concerning the use of remaining resources to ensure physical survival (See Wales and Stager for a copy of the scenario). Following a lecture on SDM and the distribution of SDM materials, students received a set of written facts describing the shipwreck scenario and asked to rank, on their own, the salvaged items from the ship in decreasing order of importance for their survival (Column A, Table 2). The exercise assumes that a search party will begin to search for the lost boat in three or four days. Students had two days to arrive at a independent solution to the assigned common problem.

The facilitator organized randomly selected teams of four or five students for the next class period. At the next class meeting, each team solved the same problem as a group with the SDM assistance of the facilitator. Teams worked in different rooms so as not to distract other teams in their deliberations. The guided design nature of the exercise subtly directed the teams through the SDM framework, following the sequence proposed by Wales and Stager, making sure they defined the problem, evaluated alternatives, and agreed on a solution. The give and take in the teams lasted for 30 minutes. The teams then were asked to produce a team ranking of the survival items available from the shipwreck (Column B, Table 2), based on their shared understanding of the problem (15 minutes). Team members compared their individual pre-exercise decisions and their team solution to the baseline solution of a subject matter expert—the hypothetical Coast Guard captain who rescues the stranded teams (Column X, Table 2). Absolute deviations from the expert opinion for both the individual and the team scores were calculated and totaled in Column Z (individual) and Column Y (Group) (5 minutes). For example, suppose a student ranked the windbreaker as the 5th most important survival article. The team, however, ranks the windbreakers as a 4 and the Coast Guard captain gives the windbreakers a 4. The absolute deviation for the student is 1 and 0 for the team as shown in Table 2. At the end of the class period, the facilitator shared insights on the benefits and risks of team learning and the organizational value of SDM.

Results

Six of the sixty-two teams experienced the "monster" of team learning. One three-person team failed to reach a solution in the time provided, experiencing complete collaborative breakdown in their deliberations. Another three-person team stubbornly voted to build a boat with the remaining materials and row away from the island in hope of rescue. Four teams failed to improve on the mean of their individual scores. Their observed failure to achieve mutual gains was due largely to a lack of team intelligence—the knowledge of how to work in teams even under guided design procedures (Robbins and Finley). However, in 90% of the teams, the "miracle" of team or group SDM was evident. Table 3 notes that substantial improvements (>20%) in decision-making were achieved by 65% of the teams.

Teams applying SDM do not always outperform individual decision-making, however. Leaving aside the two teams failing to generate any scores, thirty-nine individuals in the remaining student population of 274 students outperformed their team-generated SDM solution, that is, individual scores for 14% of the students remained lower (better) than the score produced from their team's deliberations. In some cases, these "expert" individuals had previous survival training. As a result, 10% of the teams did not experience any benefits from the team SDM (i.e. mean pre-exercise team score ≤ post-exercise team score). A majority of teams and team members, however, still experienced mutual gains. Fifty-eight percent of the teams reached a team score that was equal to or lower than any individual team member's score—important evidence of mutual gains from team learning. In addition, 86% of the students improved their survival score by participating in the team deliberation—further evidence of mutual gains.

A team member had the following experience in the exercise that generated the variables for the analysis (i.e. experience variables). As individuals entered their assigned workrooms and interacted with the other team members, they observed or noticed five characteristics about their team and themselves. The first was team size (N). Dependent on class attendance for that day, groups ranged from three to six members. Secondly, after a few minutes of discussion the team member realized the amount of knowledge, or lack thereof (LTK), on the team. Variability (V), associated with this knowledge base, across the individual team members became evident as well. Later in the team deliberation, the existence of a student expert (E) became obvious, someone who understood the problem from a technical point of view and had well-reasoned arguments for his or her rankings. Finally, the individual student eventually realized where he or she stood in survival knowledge and decision-making skills (LIK) relative to the other team members.

Limited data on individuals and teams, and the multicollinearity problems produced by creating variables from a limited variable set, precludes the proper use of multivariate analysis to predict the individual gain (G) associated with the team process using the experience variables defined above as independent variables. An alternative approach explores the simple correlation between G and the above observations made by the team member during the exercise. G_{ij} is the percent gain above the i^{th} individual's score on the j^{th} team (I_{ij}) compared to the score for the post-exercise team solution, $(I_{ij} - PETS_j)/I_{ij}$. N_j is the number of members on the jth team. Lack of team knowledge (LTK_j) is the mean team pre-exercise score (_I_i/N). V_j is the variability in the team knowledge measured by the standard deviation associated with team member pre-exercise scores (_$_{Ii}$). E_j denotes the existence of an expert (E=1) on the team with an I_{ij} score of 36 or lower representing an individual score 1.5 standard deviations below the overall pre-exercise mean score for all students. Finally, lack of individual knowledge (LIK_{ij}) measures the relative lack of pre-exercise knowledge for the team member as compared to the group's pre-exercise knowledge, I_{ij}/LTK_j.

Based on the reviewed literature, I hypothesize that team size (N) will be negatively correlated with individual gain (G) because relatively smaller teams process information more efficiently and effectively than larger teams. A contrary position is that larger teams, relative to smaller teams, have more intellectual resources and the opportunity to share a wider variety of ideas leading to a superior decision. I expect a positive correlation between G and the lack of team knowledge (LTK). The less knowledgeable the overall team is about survival (i.e. a higher LTK score) the greater the expected gains from team learning. I hypothesize a positive correlation between team variability (V) and G. People with very diverse perspectives on a problem can mutually gain, in a significant manner, from discussing their ideas and reaching a consensus decision, at least in theory. Positive group dynamics are critical in reaching a team decision in an effective manner, however. The decision analysis literature argues that expertise in the subject matter or in the decision-making process can produce better decisions. Therefore, one would expect that the presence of an expert (E) on the team would have a positive correlation with G. The decision analysis literature argues that expertise in the subject matter or in the decision making process can produce better decisions. Finally, I hypothesize that the less a person knows about the subject of survival (a high LIK value), the more the individual will gain from a team learning exercise. Therefore, I expect a positive correlation between G and LIK.

Table 4 presents the correlation results for the classroom exercise. Team size (N), team variability (V), and the existence of an expert on the team (E) reveal a small positive or negative relationship with G—in fact, the relationships are nearly neutral. Team size ranged from three to six but most teams had four or five members. This lack of variability in team size lends some support to the literature that teams of four to five individuals are a near optimal size for solving problems. Team variability also had virtually no correlation with individual gains from team decision-making. Individuals appeared to gain from the SDM and the team process no matter how similar or dissimilar their survival knowledge. The presence of an expert on the team does not correlate with substantial gains from the SDM or team process. In fact, the negative correlation implies some minor friction in the expert's efforts to influence the thinking of other team members. Several expert-less teams performed as well or better than teams with one or more experts.

As hypothesized, individuals on teams with little aggregate *a priori* survival knowledge gain from the team exercise, albeit in a moderate fashion. Via the SDM process, team learning has a positive impact on individual performance. As expected, individual team members with less survival knowledge relative to other team members gain significantly from working sequentially on a problem in the team. Whether these gains are due to free riding or actually internalized by the participant is unknown but worth further research.

So What?

Working and learning in teams in and outside the academic classroom is fraught with "monster" implications for the economics and management instructor. Free riding, uneven preparation, sporadic attendance, plagiarism, and the opportunity cost of material replaced by the in-class group exercise are only a few of the hurdles the instructor must overcome to facilitate successful team projects. Yet the "miracle" potential of team activities, not only to enhance learning but also to prepare students for their careers, dominates the downside risks of student interaction in groups (Michaelsen and Black).

Individual active learning outside the classroom via homework assignments is standard offering in economics classes. However, group-based mutual gains learning may or may not occur in these assignments. Within the classroom, however, research has demonstrated that active individual and group processes enhance learning on the margin more than the equivalent time spent on more traditional forms of presentations (see Wilson, Fairchild, Willett and Erven for a summary of this literature). The research reported in this teaching note provides evidence that students with little experience in survival and serial decision-making gain significantly from their interaction with other team members in a guided design process.

Action or team learning projects can be an effective and efficient tool for teaching managerial decision-making and for teaching economic principles as well. The instructor can create the give and take of economic decision-making in organizations to produce mutual learning gains in the classroom. Some economic educators have gone so far as to associate doing economics to detective work (Breit and Elzinga), while others promote role-playing (Alden) and case studies (Carlson and Schodt, Velenchik) as potential team-based tools for learning economic theory and conducting policy analysis. The increasing number of short problem-solving case studies in managerial economics textbooks (e.g. Mansfield, et al.) has laid the didactic foundation for incorporating team learning into our classrooms. Our ongoing instructional challenge is to utilize these available resources regularly and appropriately to prepare our undergraduate students for productive citizenship within the give and take work environment of organizations.

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Table 1: Selected examples of serial decision making (SDM)

Altier (Decision Analysis)	*Kepner and Tregoe* (Decision Analysis)	*Lyles* (Decision Making)	*Wales and Stager* (Decision Making)
1. Define the Decision Statement	1. Establish Objectives	1. Define Objectives	1. Identify the Problem
2. Establish Objectives	2. Rank the Objectives	2. Generate Alternatives	2. State the Basic Objective or Goal
3. Value Objectives	3. Develop Alternative Actions	3. Develop Action Plan	3. State the Constraints, Assumptions and Facts
4. Generate Alternatives	4. Evaluate Alternatives Against Established Objectives	4. Troubleshoot	4. Generate Possible Solutions
5. Compare and Choose	5. Tentatively Choose the Best Alternative	5. Communicate	5. Choose the Best Solution
	6. Explore Tentative Decision for Future Possible Adverse Consequences	6. Implement	6. Analysis
	7. Control Effects of the Final Decision by Taking Action to Prevent Possible Adverse Consequences and by Making Sure Actions Decided on Are Carried Out		7. Synthesis
			8. Evaluate the Solution
			9. Make Recommendations
			10. Report the Results
			11. Implement the Results
			12. Check the Results

Table 2: Example ranking and scoring sheet for an individual and team

Items Available	**Individual**		**Team**		**Expert**
Each person has	**A**	**Z**	**B**	**Y**	**X**
a. one windbreaker	5	1	4	0	4
b. one poncho	4	1	2	3	5
c. one sleeping bag	3	3	5	1	6
d. one pair of sunglasses	6	1	10	3	7
The boat contains					
e. a cooler with two bottles of pop per person and some ice	1	7	1	7	8
f. one large flashlight	9	7	6	4	2
g. one first-aid kit	7	2	8	1	9
h. fishing equipment	8	4	3	9	12
i. matches, rope, and a few tools	10	7	9	6	3
j. one compass mounted on the boat	11	0	12	1	11
k. two rear-view mirrors which can be removed from the boat	12	11	7	6	1
l. one "official" navigational map of the area	13	3	13	3	10
m. one salt shaker (full)	14	0	14	0	14
n. one bottle of liquor	2	11	11	2	13
Total		58		46	

Source: Wales and Stager

Table 3: Magnitude of improvement in survival score associated with team process

Improvement Attributed to Team Exercise[1] (Percentage Change)	Number (%) of Teams (N=62)
Team Failure	6 (10)
1-10%	9 (14)
11-20%	7 (11)
21-30%	21 (34)
> 30%	19 (31)

Data Source: Data collected in the class AREC 450/550 “Financial Management for Agribusiness”, Department of Agricultural and Resource Economics, University of Arizona, 1986-2002.

1. Improvement (percentage change) is measured as the mean of the individual scores for the team (combined totals from column Z divided by the number of team members) minus the team score (total for column Y, Table 2) all divided by the mean of the individual scores for the team.

Table 4: Pearson correlation between experience variables and individual gain from team process (G)

Experience Variable	Hypothesized sign of effect	Actual Pearson Correlation (p value; H_0: r = 0)
Team Size (N)	Positive or Negative	-0.08 (0.18)
Lack of Team Knowledge (LTK)	Positive	0.18 (0.00)
Team Variability (V)	Positive or Negative	0.06 (0.32)
Expert (E)	Positive	-0.09 (0.15)
Lack of Individual Team Member Knowledge (LIK)	Positive	.71 (0.00)

N=274