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Effects of Group Composition and Consensus Training on the Assembly Effect

C. Keith Waugh

Southern Illinois University at Carbondale

Author:

C. Keith Waugh
Department of Workforce Education and Development
212 Pulliam Hall
Southern Illinois University at Carbondale
Carbondale, IL 62901-4605
618-453-4868
ckwaugh@siu.edu

ABSTRACT

In light of the growing reliance on teams to solve the complex problems faced in organizations, research that demonstrates how team performance can be improved beyond the performance of individuals is warranted. This study investigated whether group performance could be significantly improved by forming groups with members heterogeneous in information-processing preferences, as measured by the Myers-Briggs Type Indicator (MBTI), and by providing those groups with training to facilitate consensus on the group's solution to a complex, multistage decision task. Comparisons of assembly effect occurrences (i.e., solutions of higher quality than those that could be achieved by any individual within the group working alone) among undergraduate student groups ($N = 38$) differing in composition (homogeneous vs. heterogeneous) and mode of consensual training (trained vs. not trained) were conducted through a nonparametric statistical analysis. The results of the analysis supported only the hypothesis predicting that the proportion of trained groups producing the assembly effect would be significantly greater, statistically, than that of the not-trained groups. However, a statistically significant interaction effect in a nonhypothesized direction was found. Implications and recommendations based on the findings are offered.

EFFECTS OF GROUP COMPOSITION AND CONSENSUS TRAINING ON THE ASSEMBLY EFFECT

In recent years, there has been a virtual explosion of foreign organizations vying for a share of the world's industrial markets. In response, American organizations have made concerted efforts to remain competitive through increased productivity, quality, and responsiveness to the needs of customers. Among these efforts is the replacement of traditional, autocratic management structures with self-managed work teams in the hopes that teams of personnel can more effectively solve the often complex and ambiguous problems faced in organizations (Bunning & Althisar, 1990; Wilgus, 1991).

Organizations' growing reliance on teams over individuals to solve organizational problems is likely based on the belief that teams can produce what Collins and Guetzkow (1964) term the "assembly effect" (i.e., solutions of higher quality than those that could be achieved by any individual within that team working alone). In general, groups do appear to produce both more and better solutions than the average individual (Hill, 1982). However, as Salazar (1995) notes, "the literature is replete with historical and laboratory examples of cases in which groups do not perform in a manner consistent with the abilities of their members" (p. 170). In fact, in many instances groups actually produce solutions of poorer quality than might be expected given the knowledge, skills, and abilities of its members. Thus, the actual benefit derived from establishing

a team rather than relying upon its most capable member to solve an organizational problem remains in question.

Based on his review of literature, Hill (1982) concludes that two conditions seem necessary for groups to achieve assembly effects when solving complex, abstract problems. The first involves "pooling pieces of information" in which individuals with skills, traits, and knowledge that don't overlap but are essential to producing a decision of high quality are brought together as a group. The value of composing groups with members who are heterogeneous on a relevant dimension is that the group will have at its disposal a greater number of unique, alternative perspectives to the problem at hand (Shaw, 1981). Conversely, limited resources would be available to groups composed of homogeneous members. As a result, the quality of these groups' decisions would likely suffer.

Along the dimensions of ability, gender, and various personality measures, the proposition that heterogeneous groups will perform most cognitive tasks better than homogeneous groups has generally been supported (Aamodt & Kimbrough, 1982; Goldman, 1965; Hoffman, 1959; Hoffman & Maier, 1961; Lampkin, 1972; Laughlin, Branch, & Johnson, 1969; Ruhe, 1978). More recently, a dimension that has shown particular utility for composing groups is that of individual information-processing preferences measured by the Myers-Briggs Type Indicator (MBTI). Specifically, groups composed of members differing in MBTI functions have been found to produce better solutions to complex, ambiguous problems than groups composed of members with the same functional types (Brocato & Seaberg, 1987; Kandell, 1992). Yet, despite the apparent utility of basing group composition on MBTI functions to improve group problem-solving quality, only a small percentage of the heterogeneous groups in these studies produced the assembly effect. Therefore, it appears that simply bringing heterogeneous members together to "pool their input" is not sufficient to produce the assembly effect.

Hill (1982) suggests that a second condition necessary to produce the assembly effect is a method that will utilize the unique resources of the members and foster the integration of those resources into the group's solution. As evidenced in the Burlison, Levine, & Samter (1984) study, free interaction among members provides the greatest opportunity for member resources to be utilized. However, while the groups in the free interaction condition produced solutions to complex problems that were significantly higher in quality than those groups where interaction was restricted, the solutions produced by the interacting groups were still no better than the solutions produced by the best individuals within the groups. Thus, in light of their findings, free interaction by no means guarantees that member resources will be integrated to produce the assembly effect.

Clearly, what is required is a method which fosters the integration of each member's input into the final solution. Such a method is consensus. Wood (1988) writes:

Consensus decisions reflect the views of all members and have the acquiescence and, ideally, the support of all members. A consensus

decision is one that all members have a part in shaping and that all find at least minimally acceptable as a means of accomplishing some mutual goal. (p. 186)

If groups approach consensus properly, many of the debilitating communication patterns that lessen group performance can be avoided. However, evidence suggests that neither researchers nor practitioners should take for granted that groups understand or are capable of reaching "true" consensus without training. For example, Nemiroff and King (1975) found that groups who were given no training in techniques to reach consensus, but left to their own devices, tended to resort to alternative, nonconsensual behaviors such as majority voting, averaging, and trading to produce a solution. Thus, it appears that group consensus rarely comes naturally. Groups must be *taught* how to reach consensus. Further, groups that received training regarding how to arrive at a consensual solution to a complex problem reached consensus and produced decisions of higher quality than those groups that were not trained.

The results obtained by Nemiroff and King (1975) also provide evidence that groups trained in reaching consensus are more capable of achieving an assembly effect. Seventy-two percent of the trained groups surpassed the achievement of their most proficient member, while only 33 percent of the not-trained groups achieved the assembly effect. Nemiroff and King conclude that the "consensual techniques employed by instructed groups were superior because they promoted a fuller sharing of ideas among participants" (p. 18). Thus, the consensual technique appears to provide a method by which the resources of members can be effectively integrated.

PURPOSE OF THE STUDY

The purpose of the present study was to build upon the knowledge currently established in small-group research. Specifically, this study sought to demonstrate that while basing group membership on differing MBTI functions is a valid method of ensuring heterogeneous perspectives, training that will facilitate group consensus is essential for the production of group decisions with higher quality than those of its most capable member. The study was guided by the following null hypotheses:

- H1: There is no statistically significant difference in the proportion of heterogeneous groups and homogeneous groups achieving the assembly effect.
- H2: There is no statistically significant difference in the proportion of trained groups and not-trained groups achieving the assembly effect.
- H3: No interaction effect is evident in that there is no statistically significant difference in the proportion of heterogeneous/trained groups, heterogeneous/not-trained groups, homogeneous/trained groups, and homogeneous/not-trained groups achieving the assembly effect.

METHOD

Participants and Measures

Two hundred and two undergraduate students enrolled in General Psychology and Psychology of Personality courses at a medium-sized university were given Form G of the Myers-Briggs Type Indicator (MBTI) (Myers & McCauley, 1985) and a brief demographic questionnaire to complete. Form G of the MBTI is a 126-item instrument designed to measure type preferences on each of the four following dimension: extrovert – introvert, sensing – intuition, thinking – feeling, and judging – perceiving. The bipolar aspects of these dimensions are described below:

Extrovert – Introvert

- Extrovert – prefers to focus attention on the external world of people and things.

- Introvert – prefers to focus on the internal world of ideas and feelings.

Sensing – Intuition

- Sensing – prefers detailed, factual information acquired through the senses.

- Intuition – prefers to focus on the theoretical relationships among facts, forming concepts and ideas relating to the “bigger picture”.

Thinking – Feeling

- Thinking – prefers to base decisions on logic and reason.

- Feeling – prefers to base decisions on personal values and the impact that the decisions will have on others.

Judging – Perceiving

- Judging - prefers schedules, resists spontaneity and seeks to establish order in their work and in their lives.

- Perceiving – prefers to be flexible and spontaneous, resisting confinement to plans and schedules.

In general, the psychometric properties of the MBTI are considered to be acceptable by current social science standards (Murray, 1990). As noted by Carlson (1989), the majority of test-retest reliability studies show test-retest correlations ranging from .75 to .89 over a 4 week to 21 month span for the extrovert-introvert, sensing-intuition, and judging-perceiving scales. The thinking-feeling scale shows slightly lower test-retest correlations typically ranging from .55 to .79 over the same time period (Carskadon, 1977; Carskadon, 1979; Levy, Murphy & Carlson, 1972).

Further evidence for the reliability of the MBTI is provided through split-half, product-moment correlation coefficients of continuous MBTI scores. Most relevant to the present study, male and female “traditional college students” (N = 11,908) administered Form G of the MBTI produced split-half reliability coefficients of .82 on the extrovert-introvert scale, .81 on the sensing-intuition scale, .82 on the thinking-feeling scale, and .86 on the judging-perceiving scale (Myers & McCauley, 1985).

Studies utilizing factor analysis and correlation have generally supported the content and construct validity of the MBTI. For example, after performing a factor analysis of data collected

from 200 undergraduate students, Carlyn (1977) found that the MBTI items loaded appropriately and independently on the four dimensions. More recent studies have reaffirmed Carlyn's findings (e.g., Thompson & Borrello, 1986). After reviewing 20 studies incorporating a variety of populations, including undergraduate students, Myers and McCauley (1985) observed that the MBTI significantly correlated with similar personality and interest measures such as the Adjective Check List, Minnesota Multiphasic Personality Inventory, Strong-Campbell Interest Inventory, and the Kuder Occupational Interest Survey, thereby supporting the instrument's construct validity.

Group Formation Procedures

The students' MBTI results were computed, and replicating Kandell's (1992) method of group formation, students were assigned to groups based on gender and MBTI type. Specifically, each group was constructed with at least one member opposite in gender to minimize the effects of gender homogeneity. Further, students were placed into four-member groups based on their preferences for perceiving (i.e., sensing - intuition) and judging (i.e., thinking - feeling). Thus, homogeneous groups were comprised of members who all shared a perceiving and judging preference while heterogeneous groups were comprised of members who differed in function pairings (i.e., a sensing - thinking member, a sensing - feeling member, an intuition - thinking member, and an intuition - feeling member).

The preference scores for extroversion - introversion and judging - perceiving were not considered during the formation of groups in the Kandell (1992) study. Nor were they considered in the present study. Kandell (1992) defends the exclusion of the extroversion - introversion and judging - perceiving preferences, basing group assignment solely on the sensing - intuition and thinking - feeling preferences, by arguing that these functions "relate most closely to the cognitive processes of problem solving and decision making" (p. 18). In light of his finding that heterogeneous groups outperformed homogeneous groups based on this assignment, Kandell's argument is convincing.

While the method of group formation has been replicated, the present study deviates from Kandell's in the number of members in each group. While Kandell created groups with 5-6 members, groups in the present study consisted of only 4 members. Thus, the ratios of males to females, as well as the ratios of differing functions in the heterogeneous groups, cannot be compared.

Initially, 51 groups were designated to participate in the experimental phase of the study. However, because 13 subjects failed to report for the experimental phase, several subjects were reassigned prior to beginning the phase in order to produce as many four-member groups as possible.

Forty-eight groups participated in the experimental phase of the study. However, 10 of the 48 groups were not included in the statistical analysis. The reasons for the exclusion of these groups

were as follows: a) inability to place four subjects with homogeneous sensing - intuition, thinking - feeling functions and with preference scores greater than 8 in a group ($n = 4$ groups, 16 individuals), b) fewer than four subjects in a group ($n = 3$ groups, 7 individuals), c) more than four subjects in a group ($n = 2$ groups, 10 individuals), d) inability to include at least one subject of the opposite gender in a group ($n = 1$ group, 4 individuals).

Among the final 38 groups (17 homogeneous and 21 heterogeneous) who were included in the statistical analysis, 83 group members were female (55%) and 69 were male (45%). The ages of the subjects ranged from 17 to 43 years with a mean of 20.28 years and a standard deviation of 2.67. The academic majors of the subjects were diverse, with 22 majors represented. Only 5 of the subjects (3%) failed to report their major.

Method of Group Assignment

Prior to the experimental phase, each of the 38 groups were randomly assigned to one of two experimental conditions: trained in reaching consensus and not trained in reaching consensus. The assignment of each group was based on a coin-toss. Subsequently, 20 groups were assigned to the trained condition and 18 groups were assigned to the not-trained condition. Thus, combined with group composition, a 2 X 2 factorial design with the following four cells was produced: a) homogeneous/trained ($n = 8$), b) homogeneous/not trained ($n = 9$), c) heterogeneous/trained ($n = 12$), d) heterogeneous/not trained ($n = 9$).

Experimental Procedures

The experimental phase of the study took place two weeks after the administration of the MBTI. Replicating Nemiroff and King's (1975) experimental procedures, the subjects were placed in their respective groups and each subject was given the NASA "Lost on the Moon" problem (Hall & Watson, 1971) to complete individually.

The "Lost on the Moon" problem is a multi-stage task frequently used in small-group research. The problem explains that the reader is a crew member of a spaceship that has crash-landed on the surface of the Moon. From the crash, only 15 items in working condition were salvaged from the wreckage. The task for the reader is to rank the fifteen items listed in terms of their importance for survival. The subjects' individual rankings are then subtracted from the correct rankings and the absolute deviations are added to produce a performance score.

Once this individual exercise was completed and the "Lost on the Moon" problems were collected, the groups assigned to the not-trained condition were directed to leave the room. The remaining groups were given both written and verbal instructions directing them to complete the "Lost on the Moon" problem again, but as a group. Further, the groups were provided specific written and verbal instructions detailing the procedures that they were to follow to reach a group consensus on the ranking of items during the group exercise.

Once the researcher was satisfied that all the group members in the trained condition understood the procedures, the groups in the not-trained condition were asked to return to the room, sit in their assigned seats, and complete the "Lost on the Moon" problem as a group. These groups received no instruction in consensus. Instead, they were left to their own devices to arrive at a group solution. One "Lost on the Moon" problem sheet was distributed to each group and the group exercise commenced.

Following the group exercise, the group members were given a "Decision-Style Questionnaire" to complete. The questionnaire consisted of 3 items which asked the subjects to indicate the frequency in which their group resorted to non-consensual behaviors (i.e., majority voting, averaging, trading (i.e., a member compromising with another member by giving up a wanted rank of an item in return for another item being ranked as wanted)) during the group exercise. The questionnaire served to indicate whether the treatment (i.e., consensual training) was effective in reducing the occurrence of non-consensual behaviors among the groups in the training condition. Once all of the subjects had completed the questionnaire, the experimental phase was completed and the subjects were dismissed.

RESULTS

Preliminary Analysis

Effectiveness of the Treatment. The Mann-Whitney Two Sample Test was employed to determine if the groups that received training in reaching consensus prior to the group exercise resorted to non-consensual behaviors to reach a group solution to the decision task significantly less often than groups that received no training. As shown in Table 1, the results of the analysis found that the groups that received no training in reaching consensus resorted to alternative, non-consensual methods to reach a decision on the task more often than the groups that received training. The most frequent approach incorporated by the groups in the not-trained condition was the majority vote ($M = 4.26$) followed by trading ($M = .72$). Both of these means are significantly greater than the means of the trained groups, with the first beyond the .01 level and the second beyond the .05 level.

Table 1

Mann-Whitney Two Sample Test Comparing Mean Responses Between Trained and Not-Trained Groups to Questions 1) Frequency of Majority Vote, 2) Frequency of Averaging, 3) Frequency of Trading.

Group	Q1	Q2	Q3
Trained			
<i>M</i>	.06	0.00	.01
<i>SD</i>	.24	0.00	.11
Not Trained			

<i>M</i>	4.26	.25	.72
<i>SD</i>	5.57	.96	1.54
<i>z</i> values	-5.30**	-.89	-2.40*

* $p < .05$, ** $p < .01$

The groups in the not-trained condition also resorted to averaging with greater frequency than the trained groups. However, the difference between these means was not statistically significant. Thus, the consensus training appeared to have produced the desired effect of facilitating consensual behaviors.

Interrater Agreement

To determine the extent to which members within the groups agreed with the frequency in which their group resorted to majority voting, averaging, and trading during the group exercise, the percentage of members within the groups who agreed on the frequencies was calculated. The results of this analysis found that 89 percent of the group members agreed on the frequency of majority voting, 96 percent agreed on the frequency of averaging, and 89 percent agreed on the frequency of trading. Thus, a high degree of interrater agreement among members within the groups was found.

Primary Analysis

The primary concern of this study was whether the proportion of groups that achieved an assembly effect significantly differed, statistically, between groups in opposing compositions and/or modes of training. Following the procedure of Nemiroff and King (1975), groups whose performance on the NASA problem exceeded the best performance by a member of the group during the individual exercise were assigned a value of one (1), while groups that failed to perform better than their best member received a zero (0). A Two-Sample Proportion Test was conducted to test the following null hypotheses:

- H1: There is no statistically significant difference in the proportion of heterogeneous groups and homogeneous groups achieving the assembly effect.
- H2: There is no statistically significant difference in the proportion of trained groups and not-trained groups achieving the assembly effect.
- H3: No interaction effect is evident in that there is no statistically significant difference in the proportion of heterogeneous/trained groups, heterogeneous/not-trained groups, homogeneous/trained groups, and homogeneous/not-trained groups achieving the assembly effect.

The percentages of the groups who achieved the assembly effect and the *z* values resulting from the respective comparisons are shown in Table 2.

Table 2
Two Sample Proportion Test Comparing Proportions of Groups Achieving Assembly Effect.

Comparison	<i>z</i> values
Main Effects:	
Homogeneous (71%) - Heterogeneous (62%)	.56
Trained (80%) - Not Trained (50%)	1.95*
Interaction Effects:	
Homogeneous/Trained (100%) - Homogeneous/Not Trained (44%)	2.51**
Heterogeneous/Trained (67%) - Heterogeneous/Not Trained (56%)	.52
Homogeneous/Trained (100%) - Heterogeneous/Trained (67%)	1.83*
Homogeneous/Not Trained (44%) - Heterogeneous/ Not Trained (56%)	.47
Homogeneous/Trained (100%) - Heterogeneous/Not Trained (56%)	2.15*
Homogeneous/Not Trained (44%) - Heterogeneous/Trained (67%)	1.09

* $p < .05$, ** $p < .01$

As indicated in Table 2, only the second main effect null hypothesis was rejected. Specifically, the proportion of groups in the trained condition producing an assembly effect (80%) was found to be significantly greater, statistically, than that of groups in the not-trained condition (50%), $z = 1.95$, $p = .03$.

In addition to the significant main effect of trained versus not trained, a significant interaction effect was also observed. Specifically, a significantly greater proportion, statistically, of homogeneous/trained groups (100%) achieved an assembly effect compared to the homogeneous/not-trained groups (44%), $z = 2.51$, $p = .006$; heterogeneous/not-trained groups (56%), $z = 2.15$, $p = .02$; and the heterogeneous/trained groups (67%), $z = 1.83$, $p = .03$.

DISCUSSION

Earlier research has produced evidence that groups which utilize a consensual approach to solve problems produce better solutions and have a higher probability of achieving the assembly effect than groups which fail to reach consensus (Nemiroff & King, 1975). The results of the present study add to the existing evidence that reaching a group decision through consensus significantly increases the likelihood that the group will experience the assembly effect. Specifically, in the present study the training provided to groups randomly assigned to the treatment condition promoted the use of a consensual approach when working to solve NASA's "Lost on the Moon" decision task. Further, compared to the groups that received no consensus training, a significantly greater percentage of those groups that received training and, subsequently, employed consensus during the group task produced solutions superior to those produced by any individual member within their group.

The most plausible explanation for these findings comes from Wood (1988) and others who argue that unlike nonconsensual techniques, consensus more fully integrates the resources of each group member into the final solution. Thus, there is a greater probability that the group will select the best possible solution, a solution that is better than any individual can produce on his or her own.

Also considered in this study was whether group composition based on MBTI preferences would differentially affect a group's probability of achieving the assembly effect. Earlier research indicates that group composition alone has little impact on the probability of assembly effect occurrences (Kandell, 1992). Similar results were found here. No statistically significant differences in the proportion of assembly effect occurrences between homogeneous and heterogeneous groups were evident. The present study, however, hypothesized that once training in reaching consensus is provided, the probability of achieving the assembly effect will be greatest among those groups composed of members heterogeneous in MBTI preferences. This hypothesis is based on the conditions that Hill (1982) notes are necessary for the occurrence of the assembly effect. Specifically, it is reasonable to argue that group members heterogeneous in MBTI preferences will bring to the task skills and traits that "don't overlap but are essential to producing a decision of high quality" (i.e., the first condition) and that consensus will be the result of an integration of member resources (i.e., the second condition).

However, the results of the present study suggest that, with regards to the first condition, the opposite is true. When coupled with consensus training, the probability of homogeneous groups achieving the assembly effect is significantly increased. This finding implies that practitioners could facilitate group performance beyond the performance capable by its members working alone by composing the groups with members who share sensing-intuitive and thinking-feeling preferences, and providing the groups with guidelines to facilitate consensus behaviors. However, it must be remembered that the occurrence, or non-occurrence, of an assembly effect was a nominal-scaled variable; therefore, it does not indicate the degree of improvement in performance. In other words, the measure was based on the percentage of groups that produced a group solution better in quality than the solution of the groups' best member. Thus, the measure provides no information about the extent to which the group's solution improved beyond the best member's solution.

One possible explanation for the findings in this study is that homogeneous groups are more capable of reaching consensus following training. As evidence, not only did all of the homogeneous/trained groups experience an assembly effect, but this was the only cell in which all the groups reported that they did not utilize non-consensual approaches to reach a group decision on the task. As shown in Table 3, all of the groups in the remaining cells, including the heterogeneous/trained groups, reported that they had resorted to non-consensual behaviors, with the heterogeneous/not-trained groups reporting the greatest frequency of use.

Table 3

Mean Responses Between Cells to Questions 1) Frequency of Majority Vote, 2) Frequency of Averaging, 3) Frequency of Trading

Cells	Q1		Q2		Q3	
	M	SD	M	SD	M	SD
Homogeneous/trained	0	0	0	0	0	0
Homogeneous/Not-Trained	1.44	3.04	.33	1.07	.81	1.60
Heterogeneous/Trained	.10	.31	0	0	.02	.14
Heterogeneous/Not-Trained	7.08	6.10	.17	.85	.64	1.50

This finding suggests that heterogeneous groups not trained in consensus are least likely to apply consensus behaviors and that these groups may benefit most from an extensive, structured training program in consensus techniques. Perhaps for the heterogeneous/trained groups, the training they received was insufficient. Had the consensus training been more extensive for this group, consensus, and the assembly effect, may have been achieved with greater success.

Heterogeneous groups might benefit most from extensive, structured training in consensus because it is likely that more extensive training in consensus would buffer the intragroup conflict that may result from opposing perspectives among heterogeneous members. As noted by Blake and Mouton (cited in Kilmann & Seltzer, 1977), “A group can be expected to have difficulty in completing its assignment if members do not have some similarity of compatibility of viewpoints to suggest what tasks are important” (p. 240).

Indeed, the “difficulty” among heterogeneous groups is evident in the relatively longer time it typically takes these groups to complete a task (Brocato & Seaberg, 1987). But more importantly, the quality of the solution may suffer as well; resulting in what Steiner (1972) calls a “process loss”, in which the performance of a group is poorer than might be expected given the capabilities of its members.

Training in consensual behaviors may serve to reduce the conflict within these groups that would otherwise hinder performance. However, given the fact that intragroup conflict was not directly measured in this study, this assumption is tenuous. Clearly, further research incorporating measures of intragroup conflict among members differing in MBTI functions is needed.

Research incorporating alternative conditions, decision tasks, and different populations is also needed. Group performance researchers have primarily used ranking exercises as the decision task and undergraduate students as the subjects in carefully controlled conditions. While much has been learned from these studies, the application of these findings to real-world events experienced in today’s organizations are not without caveats. Organizational problem-solving groups would rarely experience the carefully controlled conditions that were present in this study.

Indeed, groups within organizations are undoubtedly confronted with a variety of conditions that affect their ability to function effectively and produce optimal solutions. For instance, organizational politics, personal agendas, member status, and/or prior history with group members are conditions that would likely influence a group's ability to function effectively. These conditions are likely not as intense among undergraduate student groups.

Further, rarely do organizational problem-solving groups enjoy the knowledge that a correct solution to the problem at hand exists, and that their only task is to find the correct solution by manipulating the information that has been provided. In reality, the complexity of problems faced by organizations often extends far beyond the problem presented in this study. Clearly, quasi-experimental research studying and comparing the quality of decisions made by work groups within the realm of the organization is warranted.

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