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The Effectiveness of Electronic Brainstorming in an Industrial Setting

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ABSTRACT

An experiment was conducted comparing the effectiveness of individual versus group electronic brainstorming in addressing real-world "wickedly difficult" challenges. Previous laboratory research has engaged small groups of students in answering questions irrelevant to an industrial setting. The current experiment extended this research to larger, real-world employee groups engaged in addressing organization-relevant challenges. Within the present experiment, the data demonstrated that individuals performed at least as well as groups in terms of number of ideas produced and significantly ($p<.005$) outperformed groups in terms of the quality of those ideas (as measured along the dimensions of originality, feasibility, and effectiveness).

Key words: brainstorming, electronic media, groups vs. individuals, "wickedly difficult" problems.

INTRODUCTION

In today's highly dynamic and competitive world, it is essential that organizations generate novel ideas of high quality to develop or maintain their competitive advantages. Historically, one method of idea generation has been verbal brainstorming, a process where groups of individuals, typically in the same room, work to create and exchange ideas. Popular opinion holds that verbal brainstorming yields more (and better) ideas than the same number of individuals working alone would produce [5, 7, 11]. However, verbal brainstorming has been found to result in certain undesirable consequences (such as evaluation apprehension, production blocking and social loafing) when compared to individual, or nominal, brainstorming [9]. To address some of these limitations, electronic brainstorming (EBS) has been proposed as an alternative. An EBS session consists of individuals interacting and exchanging ideas via a computer. While EBS has been shown to be superior to verbal brainstorming, the research comparing EBS to electronic nominal brainstorming has produced rather mixed results with some research finding EBS superior to electronic nominal groups [12], some researchers finding electronic nominal groups superior to EBS [1] and others finding no difference between the two groups [4].

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To date most of the research in this area has been performed in laboratory settings with college students electronically brainstorming about industrially irrelevant topics, leaving generalizability to industrial applications unclear. There are several key differences that must be addressed in order to apply the existing research to an industrial setting. First, most research has studied three- to four-person student groups, rather than larger work teams that leverage diverse skill and knowledge bases. Second, it is unclear how results from short, one-time brainstorming sessions generalize to real-world situations where groups of individuals brainstorm over a period of time. Third, students are often presented with irrelevant topics whereas groups in typical industrial settings grapple with "wickedly difficult" problems (i.e., problems characterized by a lack of agreement about the very nature of the problem itself; [15]). The current literature's brainstorming topics are not as related to students as a "wicked" problem might be to a vested employee. Fourth, while assessing the quantity of ideas is often the focus in research conducted in college settings, the *quality* of ideas may be a more important metric when considering "wickedly difficult" issues.

An experiment to investigate these issues was conducted at Sandia National Laboratories in the summer of 2007. Specifically, this experiment explored the effectiveness of EBS within the industrial setting of a modern, national research laboratory. To date, most of the research performed in this area has involved college students in an experimental setting; thus, this study extends the research to a more applied setting with practical applications. Over the course of four days, employees and contractors at Sandia voluntarily enrolled and contributed ideas in the web-based brainstorming experiment. The participants were randomly assigned to either group or nominal electronic brainstorming conditions and were asked to work on a "wicked" problem proposed by Sandia President Tom Hunter. Both the quantity and quality of ideas were assessed.

METHOD

Participants

Participants were volunteers, including 147 employees and contractors at Sandia. Of those who enrolled in the experiment, only 69 employees who actually contributed ideas were included in analyses.

Materials

The experiment took place on a website that was created and managed by the experimenters. The participants electronically signed the informed consent and electronically completed the demographic and satisfaction questionnaires.

Procedure

Participants were primarily recruited through an advertisement in the *Sandia Daily News* (an internal news source emailed daily to Sandia employees). In addition, the experimenters sent personal recruitment emails and placed a link to information regarding the study on the Sandia intranet Homepage. The recruitment messages informed the employees that a brainstorming experiment was being conducted and would consist of electronic brainstorming (either alone or in a group) via a website for four days. Once the employees expressed interest in participating in the study, they were directed to a website which described the study in detail and informed the participants of what the experiment would entail. Once they had (electronically) signed the informed consent, the participants created a userid and password for use during the experiment and completed a demographic questionnaire. Finally, the

participants were directed to a website in which they could submit ideas to the question.

The participants were randomly divided into one of two groups: EBS or electronic nominal brainstorming. All of the participants brainstormed ideas regarding the question provided by Lab President Tom Hunter.

When the participants logged onto the website, they were shown the question and were asked to submit their ideas. Those in the electronic nominal condition worked alone and did not see the ideas of other participants. Those in the EBS condition brainstormed with others and were able to see and build off of the ideas of the other members in the group. The responses in both conditions were anonymous, being tied solely to the participant-generated userid. There were two reasons for this anonymity. First, anonymity in group brainstorming sessions has been reported to reduce evaluation apprehension [2]. Evaluation apprehension is the tendency for people to hold back ideas for fear that others will negatively evaluate them [12]. However, when anonymity is assured this fear of negative evaluation may be reduced. Second, by presenting the participants with their peers' performance (because the participants were able to view which userid came up with each idea), the participants might be less likely to engage in social loafing [8, 13].

Participants in the EBS conditions were asked to adhere to the rules of brainstorming per Osborn [11]. In addition, the participants were told that abusive language and name calling would not be tolerated, and those who did not follow the rules would be locked out of the experiment.

At the end of the experiment, the participants were asked to complete a Satisfaction Questionnaire [3]. The questionnaire asked several questions regarding satisfaction with the experiment, along with motivation and interest in the task.

RESULTS

Quantity Analysis

In order to measure the effectiveness of the brainstorming sessions, we assessed the quantity and quality of participant responses. The number of unique ideas generated within the nominal and group conditions was counted. A repeated measures analysis of variance (ANOVA) was performed on the number of ideas expressed on each of the days (Day 1, Day 2, Day 3, Day 4) by research group membership (nominal or group). There was a significant effect for the number of ideas expressed on each day (Wilks' lambda, F (3, 65) = 2.784, p = .048, η_p^2 = .114) in which there was a larger number of ideas put forward on day one compared to the following three days. However, there was no significant difference in the number of ideas between the group and nominal conditions. In fact, absolute values favored the nominal condition (mean = 6.26, SD = 12.85) over the group condition (mean = 4.66, SD = 9.21).

Quality Analysis

In addition to quantity measures, responses were also examined for quality. In order to perform this analysis, responses were summarized into general concepts representing each participant's answer to the Hunter question. Responses unrelated to the question, like those addressing the website design, were not considered. Following the example of Barki and Pinsonneault [1], the quality of each idea was scored

according to the three separate dimensions of originality, feasibility, and effectiveness. In this scoring scheme, *originality* referred to the extent to which the idea was novel, *feasibility* referred to the extent to which the idea was precise and the ease with which it could be implemented and *effectiveness* referred to the extent to which the idea helped to solve the given problem. Two raters were chosen due to their background and experience in operations management and industrial/organizational psychology. The raters independently scored the ideas on these qualities using a seven point Likert Scale with one corresponding to low evidence for the component and seven corresponding to high evidence for the component. The ratings were then averaged for each idea. Because the most meaningful ideas were of the most interest, the maximum ratings rather than average ratings were evaluated. Thus, if a participant received ratings of 3, 4, and 5 for a particular day, the maximum rating of 5 was used as that participant's dependent value. Independent samples t-tests comparing the two conditions (nominal and group) on each of the three quality dimensions were conducted to independently evaluate originality, feasibility, and effectiveness. Significant differences were found for all t-tests such that the nominal condition outperformed the group condition for originality (t = 3.69, p < .001), feasibility (t = 2.39, p = .02) and effectiveness (t = 2.65, p = .01).

Satisfaction Analyses

The groups' responses to questions on the Satisfaction Questionnaire were also compared using a t-test. While we did not obtain a significant difference between the two groups (likely due to the small number of respondents, n = 9), our data suggest that the participants in the EBS group were generally more satisfied, motivated and interested in the brainstorming task than were those in the nominal condition which is consistent with what has been established in the literature [3, 6, 14].

DISCUSSION

Our primary empirical finding demonstrates that within the given experimental design electronic nominal brainstorming is at the very least as effective as electronic group brainstorming. Although there was no difference in the number of ideas generated by the groups, the nominal condition outperformed the group condition in terms of the quality of ideas. The quality of the ideas in the nominal condition was significantly better across all three quality ratings, including originality, feasibility, and effectiveness. Although these results are preliminary, they demonstrate that employees may effectively use electronic nominal brainstorming as a cost effective means to work on wickedly difficult problems.

The finding that individuals are more successful than groups in electronic brainstorming suggests a time- and cost-savings potential for companies. Generally, when electronic group brainstorming is compared to verbal brainstorming, it is touted as having the advantages of shorter meetings, increased participation by remote team members, better documentation via electronic recording, improved access to the meeting records and, importantly, cash savings [5]. When there is no longer the mandate that these electronic communications occur concurrently, these advantages would seem to be even greater. One might assume that participants in an electronic nominal condition would require less time to contribute ideas as compared to those in a group condition where they would (ideally) read the other postings before giving their ideas. On the other hand, at least some of the submissions suggested that they were prepared offline and pasted into the web site forms. Thus an evaluation of the time savings in this experiment is not addressed. However, nominal brainstorming does allow for increased participation due to greater scheduling flexibility.

In sum, our data demonstrate that within the current industrial setting and electronic interface, nominal brainstorming was at least as effective as group brainstorming. This study is to our knowledge one of the first to empirically examine brainstorming within an industrial setting. Additionally, the current experiment is the first to extend brainstorming groups beyond the typical 3- or 4-person groups (occasionally 12-person) to large, 30-person groups. It is also the first to examine how a longer duration of 4 days affects results.

While our results demonstrate that nominal brainstorming is as effective as group brainstorming, more research is necessary in order to fully circumscribe the generalizability of this finding to other questions, interfaces, and industrial settings. Future research may compare different computer-mediated technologies, interfaces, and experimental manipulations. For example, a more wiki-like interface might allow users to build on other people's ideas more easily than the interface used for the current experiment and, thus, outperform a nominal group. In addition, other "wickedly difficult" questions could be addressed as well as electronic brainstorming performance at alternative industrial settings.

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