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# Can a Group Support System equipped with Group Cognitive Maps reduce Cognitive Conflicts?

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**Abstract.** A process for resolving cognitive conflicts among group members with the help of cognitive maps and a group support system has been proposed. Cognitive conflicts have been studied in the context of Social Judgment Theory. The model involves a set of criterion events, a set of cues, and a set of judgments about those events, based on observation of those cues, by a set of judges. Disagreement arises because the judges fail to understand each other's judgment making policies. Cognitive maps, which are designed to capture the structure of a person's causal assertions, can be used as a cognitive feedback mechanism that makes a decision-maker aware of his own cognitive orientation as well as that of others and help reduce differences. Since group support systems have been successfully used to manage conflicts, it is proposed to use the cognitive mapping technique within the purview of a group support system. A set of hypotheses are proposed to test the effect of the proposed process on the group's judgment-making capability.

**Keywords:** cognitive conflict; cognitive map; group support system

## 1 Introduction

Group decision-making process is the dominant process of decision making in all business organizations as well as non-profit organizations such as, educational institutions. Although group decision-making has been conceptualized as a social process, which takes individual preferences and aggregates them into a single group preference, achieving consensus is not always easy even when the decision makers have a common interest in arriving at a shared group decision that has no conflict with their personal interests. Decision-making tasks of this nature are called cognitive conflict tasks [25], where though the group members have similar interests in solving the problem and have no conflict of interest between them, their approaches to solving the problem may be very different, which they fail to understand well causing the whole group to perform poorly in producing the group outcome. In this paper, we explore the role of individual cognition and group cognition in cognitive conflict tasks faced by groups. More specifically, we examine how cognitive mapping can be used as a tool in group decision support systems to resolve cognitive conflicts, and we propose a framework leading to a set of hypotheses regarding the impact of using a

cognitive mapping tool on some characteristics of group judgments, which involve cognitive conflict tasks. This paper reports a work in progress.

## 2 Background and Prior Research

One frequently adopted group decision-making process, which may also involve working on a cognitive conflict task, comprises group discussion followed by casting of ballots or votes to arrive at a decision favored by the majority of the group. Though such group decisions are socially accepted, the minority group whose views are not reflected in the final decision, while contractually bound to the group decision, do not commit themselves to it as strongly as the majority group does [36]. An example would be a committee set up to hire systems analysts in an IT firm where the members of the committee may have conflicting views on how different attributes such as, knowledge of specific programming languages, experience with particular software development environments, communication skills, business knowledge, professional certifications, and length of industry experience among others will be prioritized. A typical approach to making the hiring decision would be to discuss the various candidates and their strengths and weaknesses, followed by the committee members casting their votes with the candidate getting the most votes being hired. The minority group may resent the lack of a systematic evaluation of the candidates' attributes and consequently feel less committed to welcoming a new colleague into their team. This exemplifies that without a shared approach to the conflict resolution scheme, the best efforts of the team are not always forthcoming and the organization performs at less than its optimum level.

### 2.1 Cognitive Conflict Tasks

Group decisions that result in such state of affairs are likely to occur when the group of decision makers works on tasks that have been classified by McGrath [25] as involving cognitive conflict tasks. Cognitive conflict tasks involve making judgments, which is different from making a decision in the way that there is no optimal solution. The quality of the judgment would be assessed to be good if it is found that the actual outcome from the judgment turned out to be close to the expected outcome. In a cognitive conflict task setting, the group members have similar interests in achieving a common goal and the group members do not have conflicts of interest, but the process of generating a group judgment often moves the group towards conflict, disagreement, and misunderstanding among group members, often leading to judgments that are of low quality, or even failure of the group to arrive at a consensus judgment [9], [33]. Cognitive conflicts arise because the members view the problem from different perspectives, based on their private set of beliefs and values that were formed from previous knowledge and experience. These beliefs and values influence the processing of information by the individual and may make the person incapable of processing information consistently and to understand the positions taken by other group members about decision issues.

Cognitive conflicts have been studied in the context of Social Judgment Theory proposed by Brehmer [6]. The theoretical basis of Social Judgment Theory is built upon Brunswik's theory of probabilistic functionalism [7] and its descendant, the lens model [21]. The Social Judgment Theory model states that individuals evaluate complex environmental patterns or events based on a variety of cues, but only probabilistically. That is, if a certain set of cues is present, a certain environmental condition is likely, but not surely, to occur. The model involves a set of criterion events, a set of cues, and a set of judgments about those events, based on observation of those cues, by a set of judges. When two or more judgment makers, or judges, are trying to arrive at an agreement on a common problem, their disagreement may be based on underlying differences in the structure of their judgments – the way their cues are weighted, the organizing principle, and the function form. This pattern or structure of judgments is called the judge's judgment policy. In a traditional judgment development process that typically involves juggling with multiple cues that can often be conflicting in nature, the decision maker is not always aware of the underlying policy he or she is using to make his or her judgments. The availability of a decision aid that helps a decision maker describe a judgment policy accurately and consistently is likely to help the decision maker better understand his or her judgment policy, and also to appreciate the judgment policy of other group members.

According to the SJT model, most judgment policies may be represented as a linear combination of cues [6]. The linear model can be represented by

$$y_i = \sum_{k=1,m} b_{ik} x_k \ . \qquad (\mathbf{1})$$

where $y_i$ is the judgment of individual i, m is the number of cues, $b_{ik}$ is the weight for individual i on cue k, $x_k$ is the value of cue k.

To structure the judgment policy according to the SJT model, the decision makers must first collect the set of cues most appropriate to the task. Cognitive conflict tasks are often characterized by the existence of multitude of cues that can be adopted. Typically, however, only a few are known to any decision maker and each decision maker may know cues that are not known to the others. Though a considerable amount of data on the characteristics of alternative judgment policies may exist, only some of the information may be of interest to the various participants and that, too, with varying focus and level of interest depending on the influence of their belief systems. The decision makers are uncertain of their needs which may differ based once again on their individual belief systems. There is an opportunity for using appropriate decision support tools here to make the decision making process in cognitive conflict tasks more efficient in an environment where the decision makers come in with their different belief systems, have limited cognitive capacity, may face conflicting criteria, and work under time pressure.

A set of general principles have been found to be useful to structure the conflict resolution process [28], [31]. Those principles are: (a) improve communication among participants, (b) separate people from the problem, and (c) use objective data and criteria, (d) structure the problem, and (e) reduce the differences in cognitive orientation among the decision makers by making every decision maker aware of his/her own cognitive orientation as well as that of others through cognitive

feedbacks. The theoretical basis of providing cognitive feedback to the decision makers in order to improve group judgments is explored next.

### 2.2 Individual and Group Cognition

Cognitive feedback has been successful as an aid to decision-making in both individuals and groups [18]. Research in image theory has found that the ability to create and use visual, mental images is related to better problem-solving performance [30]. Individual cognition and group cognition have been of interest to researchers when studying how learning organizations work. Because learning organizations are generally quickly able to adapt to fast changing environment, researchers have conceptualized organizations as thought capable mental entities [32] and that organizations posses some form of a group-level mental model [22]. The organizational cognition is the shared understanding that the managers of the organization have in common with each other, and an individual manager's cognition is the idiosyncratic knowledge that the manager possesses [26].

Cognitive conflict tasks, also known as judgment tasks, are common in any organization including learning organizations. An example of such a task is hiring an employee, about which all members of the hiring committee have the same goal, which is to hire the person who will best fit the position. However, each member is likely to have his or her personal belief as to which characteristics make an applicant the best fit. The greater the shared understanding between the members of a group, the greater are the chances of the team's effectiveness to be superior [8]. Sharing each decision maker's understanding of the construct of a judgment task can be expected for the group to be able to form a better quality group judgment. One way to increase the sharing of the model of understanding between individuals is to reduce the vagueness of his or her judgment policy by revealing the existence of different interpretation of the same information for all to see. For this, it will be necessary to capture and clearly reveal both the similarities and differences found in the individuals' cognition. In judgment tasks, cognitive feedback for individuals is based on the empirical analysis of the relationship between the judgments they make and the sets of circumstances, profiles, or scenarios that are being evaluated [19]. In an explanatory study of decision maker's beliefs, Ford and Hegarty [17] reported that decisions are made, in part, on the cause/effect maps that the decision makers use as a basis for evaluating various options they have available. Therefore, whatever schema or knowledge structure goes into an individual's judgment policy, cause and effect relationships should be captured. Building cognitive maps is one means of seeking out associations between variables built up by decision makers from experience and knowledge in the domain [2], [13].

### 2.3 Cognitive Mapping

A cognitive map is a graphical representation of a person's thinking about a problem or issue. It is made up of nodes and arrows that represent cause-effect relationships. They show how an individual relates to an information environment by providing a

frame of reference for what is known and believed [2]. Cognitive mapping techniques have been used to model individuals' domain-related belief systems [10], for strategic development and implementation in public and private sectors [1], and to analyze major government policy issues [13]. Fiol and Huff [14] summarize the important direct functions of cognitive maps and the related indirect impacts on decision-making: they (a) focus attention and trigger memory, (b) reveal gaps in knowledge domain, (c) highlight priorities, and (d) supply missing information. These functions have important potential for decision making in cognitive conflict tasks. We make use of these capabilities in this paper by suitably integrating cognitive mapping as the means to provide cognitive feedback to the group of decision makers.

Cognitive maps have been commonly categorized upon the purpose of the maps [20]. Five categories identified by Huff [20] are: (a) maps that assess attention, association and importance of concepts, (b) maps that show dimensions of categories and cognitive taxonomies, (c) maps that show influence, causality and system dynamics, (d) maps that show the structure of argument and conclusion, and (e) maps that specify schemas, frames and perceptual codes. Attention maps (Category-a) associate frequent use of concepts (from the words used by the decision maker to describe those concepts) to important themes. Categories maps (Category-b) investigate more complex relationships among concepts and explore the range and nature of choices perceived by decision makers in a given setting. These maps will be useful when a group, in order to form the 'best' judgment policy, must explore a large variety of options that are beneficial to arrive at the consensus policy, and select the important ones for consideration. Causal maps (Category-c) lay out causal relationships between cognitive elements. Research [14] on managerial mapping has aimed largely on the causal inferences embedded in managerial thinking because the premise has been that strategic decisions are based on beliefs about causality. A decision maker considers only that information that is perceived to be relevant to finding a solution in the problem domain. Determination of the relevant information seems to depend on the cause-maps or cognitive (i.e., mental) models that decision makers carry in their intellect [17]. If so, then cause-maps are appropriate as cognitive feedback aids that will provide decision makers with better insight into their judgment policies. Cognitive feedbacks should attempt to show the logic behind conclusions and decisions to act so that other individuals can follow the arguments for another individual's judgment policy. Such feedback can be provided by argument maps (Category-d) which were used by Mitroff and Mason [27], and which not only contain causal beliefs, but take a broader look at the domain as a whole to show the cumulative impact of various evidence and the links between longer chains as a whole.

While there are many different approaches to capturing individual cognitive maps, only four of the approaches describe a method that produces collective cognitive maps [35]. These are congregate maps [5], shared maps [23], group maps [11], and oval maps [11]. Congregate maps are based on a map of a social system that is based on the individual maps that are created using the Self-Q technique [4]. However, the author did not provide a clear direction about the technique, thus leaving opportunity for researcher bias as any researcher wanting to use it will have to use his own judgment. Langfield-Smith [23] created a shared map where the participants identified ideas from the individual cognitive maps that they could share. Next, they

identified a set of relationships between the elements that they could agree upon, after which the individual maps were merged into a shared map. Both the group and oval map [11] creation techniques involve significant active participation by the researcher, which can result in researcher bias.

### 2.4 Group Support Systems

Group support systems (GSS) are computer-based systems that combine hardware, software, and procedures to structure and support group activities. Numerous studies have been done about GSS that examined the impact of GSS on decision quality, depth of analysis, equality of participation, and several other variables [15], [16]. Among the few studies that used cognitive mapping in a GSS setting, one demonstrated a method to merge individual maps and analyze both individual and collective cognitive maps [35]. Decision Explorer, which was developed to support Strategic Options Development and Analysis (SODA), is a very capable cognitive mapping software that supports group participants [12]. Cognitive maps were used to know what made object-oriented technologies difficult to understand [34]. A system called COCOMAP was developed to support organizational learning using collective cognitive maps [24]. It used a data dictionary to merge the maps and did not support graphical representation of the cognitive maps.

GSS has been used to determine if it improves outcomes of cognitive conflict tasks. A GSS supported by cognitive feedback, which was not cognitive mapping, and multiattribute-utility method was found to improve decision-making in cognitive conflict tasks [3]. Collective memory information provided by GSS speeded up decision-making of cognitive conflict tasks [29]. A group cognitive mapping methodology using a computer-based system has been demonstrated [35]. The capability of GSS to improve communication among participants, separate people from the problem, and use objective data as well as to work along side cognitive mapping software makes it a suitable system to use in supporting cognitive conflict tasks.

## 3 Scheme of Group Process

The communication and decision-support activities of GSS technology and the cognitive feedbacks provided by cognitive maps are integrated to develop an architecture of a group judgment making process that is expected to reduce cognitive conflicts in groups leading to improved group judgments. The outline of the group judgment process is shown in Figure 1. It is divided into four phases. In phase A the cues that constitute the judgment policy are identified by each decision maker. The cues of all decision makers are compiled in phase B after which, in phase C, each decision maker adopts the group's agreed upon set of cues to construct his or her own judgment policy. Finally, in phase D the individual judgment policies are aggregated in an iterative process to arrive at the group's consensus judgment policy. In each phase the decision making process is aided by cognitive maps. The detailed steps of

the process in each phase is being developed, and consequently, is not presented in this working paper.

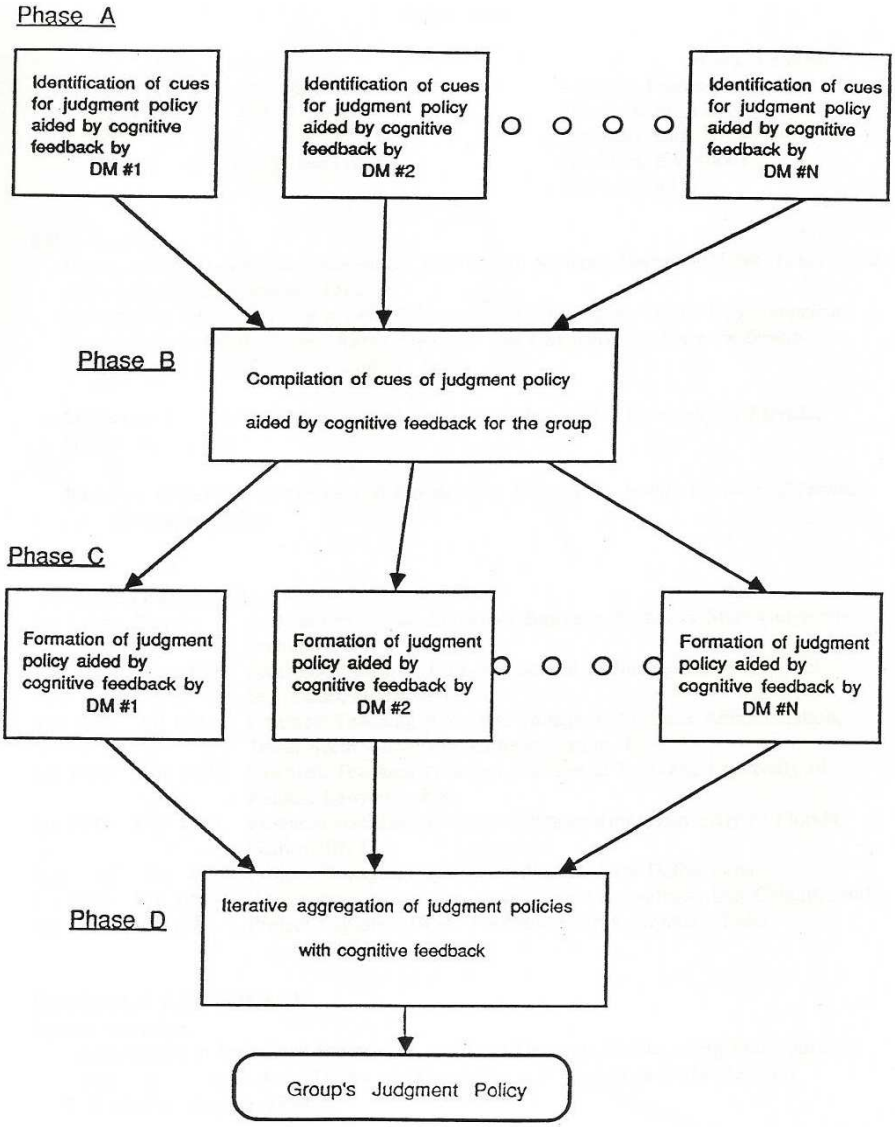


**Fig. 1.** Outline of proposed process of GSS based support for cognitive conflict tasks

## 4 Research Framework

The effectiveness of the proposed GSS supported and cognitive mapping integrated process to resolve cognitive conflicts will be determined by comparing the GSS supported process with a manual process that does not have GSS or cognitive mapping support. The comparison will be carried out in a controlled laboratory environment. Groups of three decision-makers will be randomly formed from students who will work on simulated business problems containing a cognitive conflict task. The task will require them to establish a judgment policy that they will use to achieve the task's goal, which for example, may be to select a vendor to run the student cafeteria.

The following dependent variables will be used to assess the proposed group judgment process.

- Level of disagreement: An important variable in the cognitive-conflict type decision-making situation is the agreement among group members [25]. One of the most widely studied dependent variable in GSS research is consensus, which is the general agreement among the decision-makers about the outcome of the group decision [15]. In our study, we measure the level of disagreement, which directly measures the extent of cognitive conflict among the group members, with (i) the degree of the interpersonal conflict and (ii) the degree of the post-decisional conflict.
  - If the three members of the group are identified as judge S1, judge S2, and judge S3, then the level of disagreement or degree of cognitive conflict at the interpersonal level between judges S1 and S2, represented by rC12, is (1 – coefficient of correlation between judgment ratings made by judge S1 and those made by judge S2) for the same set of cases. The degree of interpersonal conflict at the group level comprised of judges S1, S2, and S3, and represented by rCI0, is the average of the interpersonal degrees of conflict rC12 (between S1 and S2), rC23 (between S2 and S3), and rC13 (between S1 and S3).
  - The degree of post-decisional conflict for the judge S1, represented by rCt1, is (1 – coefficient of correlation between the judgment ratings made by the group of which S1 is a member and those made by judge S1 after the group process). Similarly, we have the degree of post-decisional conflict, rCt2 and rCt3 for judges S2 and S3. The degree of post-decisional conflict at the group level comprised of judges S1, S2, and S3, and represented by rCP0, is the average of rCt1, rCt2, and rCt3.
- Consistency of judgment: Judgments involving tasks that deal with a multitude of criteria some of which may be conflicting in nature can be difficult to construct. Once set up, the complexity and richness of the policy used to construct the judgment makes it difficult for the decision-makers to apply the judgment evaluation process repeatedly and consistently over the set of cases that need to be evaluated [6]. The effectiveness of the group decision-making process will depend on how consistent the group members are in applying their judgment. We propose to measure the consistency with which the individual members of a group as well as the whole group make judgments by the index of consistency. The indices of consistency, RS1, RS2, and RS3, are the coefficients of multiple

correlations between the cues and judgments made by judges S1, S2, and S3 respectively for the same set of cases. The group's index of consistency, Rt, is the coefficient of multiple correlations between the cues and the judgments made by the group.

- Accuracy of judgment: Because cognitive-conflict tasks do not have an optimal solution, it is not feasible to determine the decision quality by comparing the outcome of the group with any pre-specified or desired outcome. In the context of a cognitive conflict task, quality of judgment is reflected as judgment accuracy. In the two-system view of the SJT theory, how accurate a judge's judgment is will depend on how close the judgment is to an ideal one. The best we can simulate an ideal judgment in reality is one which is made by someone who has repeatedly made that judgment over a considerable period of time and has adjusted that judgment based on feedback from the outcome to make it as effective as possible. Then, we can use the judgment of an expert(s) in the given task environment as the reference point for assessing the accuracy of a decision-maker's judgment. The accuracy of the judgments will be measured by a judgment accuracy index. The judgment accuracy index for judge S1, represented by ra1, is the coefficient of correlation between the judgment ratings made by judge S1, and those made by the experts for the same set of cases in a task. Similarly, judgment accuracy indices, ra2 and ra3, can be effected for judges S2 and S3 in the group. Judgment accuracy index for a group comprising judges S1, S2, and S3, and represented by ra0, is the coefficient of correlation between the judgment ratings made by the group and those made by the experts for the same set of cases in a task.
- Attitude to teamwork and attitude to the judgment making process: When the group members understand the judgment policy better and are able to use it consistently, it is likely to enhance the group members' confidence and their perceived usefulness of their own decision-making. Therefore, the group members' perception of the process and outcomes of the cognitive conflict reduction scheme and their attitude towards it will be measured by having all participants complete a post-treatment questionnaire where they respond on a 7-point Likert scale.

### 4.1 Hypotheses

We simply state in this work-in-progress paper the following hypotheses that will be tested. The justification for these hypotheses will be provided in the completed paper.

Hypothesis H1: Cognitive mapping equipped GSS will reduce the level of disagreement in cognitive conflict tasks.

Hypothesis H2: Cognitive mapping equipped GSS will increase the consistency of judgments in cognitive conflict tasks.

Hypothesis H3: Cognitive mapping equipped GSS will increase the accuracy of judgments in cognitive conflict tasks.

Hypothesis H4: Cognitive mapping equipped GSS will improve the participant's satisfaction towards the judgment making process.

## 5 Significance of Proposed Investigation

The proposed research will contribute to the body of knowledge in information systems by bringing forth a cognitive mapping equipped GSS design that is expected to improve upon current state of GSSs, which rely primarily on communication mode and outcome feedbacks. With the integrated cognitive mapping the GSS is expected to improve the outcomes of cognitive conflict tasks through better understanding to a decision-maker of his own judgment formulation function, and better understanding of each other's judgment policies. The proposed architecture can be used not only to help organize and manage the flow of information regarding cognitive conflict tasks, but also to provide decision makers with a framework for assessing and communicating their judgment policies, thus leading to more consistent, and more satisfying, decision-making results. The study also attempts to integrate knowledge obtained from information systems research and cognitive science to build a decision support system that takes a realistic approach to resolve cognitive conflicts.

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