IMPACT OF GROUP MEMBER CREATIVE STYLE ON CREATIVE PROBLEM SOLVING PROCESS IN A TECHNOLOGY-MEDIATED ENVIRONMENT

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CHAPTER I

INTRODUCTION

Motivation for the study

Rapidly changing business scenarios and highly competitive markets have forced companies to recognize the need to innovate and be creative. *"The most successful organizations will have an environment where creativity and innovation are occurring consistently at all levels of the organization, and in all functions"*- (Vicenzi,2000). Global competition has created a dire need for organizations to become creative and innovative in their efforts and to meet these demands of fierce competition organizational structures are changing and becoming more flexible (Nemiro,2002). Organizations benefit from employee creativity that leads to creative ideas in the form of innovative products, processes and even marketing campaigns. Hence, an organization's most important asset are it's creative capital since creative employees are the ones who pioneer new technologies giving rise to powerful economic growth (Florida et al.,2005).

The creativity of an organization's employees is influenced among other things, by group characteristics and many other contextual factors including organizational climate, culture, strategy and technology, which impacts the organizational creativity (Woodman et al.,1993) It is important to understand these different factors that impact the process of creativity since it is related to organizational change and effectiveness (Amabile,1996; Woodman et al.,1993). Also with advances in network and communication technologies

creative teams within the organization can collaborate electronically and work together even though they are physically separated (Ocker,2005). As a result companies are now able to expand their team member bases to include geographically dispersed team members. Hence, understanding the composition of creative teams and how it impacts their performance is a very important issue (Basadur et al.,2001). Thus, it can be seen that creativity is important to organization and group creativity within the organizations can be influenced by several factors. In addition, technology is being used to support geographically dispersed teams. Hence it is important to understand how all these factors together influence the final creativity of the groups. This study focuses on how technology can be used to support creative groups that have specific member characteristics when involved in the creative problem solving process.

The following paragraphs briefly explain the creative problem solving process model used in the study and how GSS research ties in to this area and outlines the goals for this study.

Relevant Research Areas

The SIMPLEX™ Model for the Creative Problem Solving Process

Creativity as a process was first elaborated in Wallas's (1926) Model of creative thinking where he introduced the stages of preparation, incubation, illumination and verification in the creativity process. However Osborn (1953) first studied the contribution of creativity to the problem solving process and along with Parnes conceptualized the Creative Problem Solving (CPS) process. Different models were based on various refinements of the original model. Basadur et al. (1982) extended the Osborn-Parnes 3-step model to develop the SIMPLEX™ model of the creative problem solving process. Although this is

a 4-step model, the steps of Problem formulation and Problem Solving will be mainly used as the two steps in the creative problem solving process used by groups in this study.

Role of Cognitive Style in the Creative Problem Solving Process

Researchers have studied the relationship between cognitive styles exhibited by individuals and how they contribute to the creative problem solving process (Puccio et al.,2004). One useful implementation of cognitive style was developed by Basadur and his colleagues in the form of the Creative Problem Solving Profile Inventory (CPSP) to measure each individual's blend of preferences in the four steps of the SIMPLEX™ creative problem solving process. Basadur and Head (Basadur et al.,2001) extended these individual theories to groups and studied the composition of team and its impact on group performance on a creative problem solving task.

After having researched the impact of cognitive style on creative problem solving team performance, Basadur and Head (2001) indicated the need for research to understand if technology can be used to facilitate such teams. They emphasized the importance of understanding if a GSS could be used to facilitate interaction and understanding among team members that have varying cognitive styles and whether or not such a system could be used to build trust among team members and overcome some of the negative satisfaction feelings experienced by diverse group members.

Hence, it is important to study how group member's preference for specific phases of the creative problem solving process can impact the group's performance when technology is used to facilitate the process. This can provide additional insights that will help researchers and practitioners better understand the creative problem solving process for

groups and how to enhance it. In this study, the performance of groups composed of members with similar preference supported by a specific technology called Group Support Systems (GSS) will be studied. The next section outlines research that has already been done in the use of GSS for supporting creativity and how this study extends that work.

Group Support Systems (GSS) Research

The impact of technology on group collaboration began with the development of GSS which were built to support group level tasks as well as decision making (Turoff et al.,1982). The benefits of using GSS included increased efficiency, effectiveness (Gallupe et al.,1992) and greater satisfaction (Gallupe et al.,1992; Martz et al.,1992; Nunamaker et al.,1991). GSS could be used to support various collaborative processes that were undertaken by groups, including brainstorming. Brainstorming, also known as idea generation is one part of the creative problem solving process discussed previously.

A great deal of research in the area of idea generation within the Information Systems (IS) field has focused on use of GSS for supporting the group brainstorming process (Barki et al.,2001; Fjermestad et al.,1998-1999). This includes research on different brainstorming mediums; such as nominal, verbal and electronic brainstorming (EBS); where EBS applied computer-mediated communication for idea generation among the individuals in a group (Gallupe et al.,1992).

Empirical evidence suggests that EBS groups perform better when compared to face-to-face brainstorming groups (Nunamaker et al.,1991) but there is contradictory research that shows that EBS groups and nominal groups show no difference in performance

(Dennis et al.,1994; Valacich et al.,1994). Researchers have also studied different idea generation techniques (convergent as well as divergent) (Kerr et al.,2004), impact of group size (Dennis et al.,1994; Gallupe et al.,1992; Pinsonneault et al.,1999; Valacich et al.,1994), individual differences in creativity styles (Garfield et al.,2001), group history (Barki et al.,2001) and social influences (Paulus et al.,1993) and their impact on creativity in brainstorming groups.

Also, Nagasundaram and Bostrom (1995), while creating a framework for research in the use of GSS for structuring creative processes, emphasized the need to understand as well as to research how individual creativity styles and GSS impact or influence the final creativity of a group.

Measurement of GSS supported group performance

Much of the idea generation research has measured the performance of groups in terms of ideas generated(fluency) (Barki et al.,2001; Fjermestad et al.,1998-1999; Nagasundaram et al.,1995) Some researchers have judged the quality of the ideas generated with a panel of judges that assess the novelty of the ideas. This may be a fair measure of the output of a brainstorming process but it might not be indicative of the other interaction benefits of the group process. For example, it would be more meaningful to know if one type of group generated a wider variety of idea categories than another or if a specific cognitive style helped groups or individuals to elaborate more on the ideas and thus provide a greater number of ideas for comparison and prioritization as well as eventual implementation of a selected alternative solution.

The above discussions suggest that even though there is a great deal of research on how GSS can be used to support idea generation, it is important to understand that idea

generation is just the first step in the creative process. Companies will need groups to go beyond this phase. Ideas generated will have to be evaluated, selected and refined in order to be implemented within the company. Thus, the complete creative process for GSS supported groups needs to be studied in terms of the performance of groups in two phases:

1) Idea Generation: The act of Divergence where a problem is given and multiple ideas or options are generated as possible solutions; Also known as the Divergent Phase
2) Idea Selection: The act of Convergence where ideas generated in the previous phase are evaluated according to specific criteria.; Also known as the Convergent Phase

Also, even though research suggests that idea generation in groups may not be more productive than that done by individuals, companies continue to use group brainstorming (Beasley,2006; Furnham,2000) and researchers continue to examine this issue (Rietzschel et al.,2006). This suggests that they believe there is some additional value derived from group brainstorming that has not yet been explained by the traditional measures GSS supported group performance. This study will try to address some of the issues that were outlined in this section. The specific objectives and research questions for this study are explained in the next section.

Purpose of the Study and Specific Research Objectives

The purpose of the study is to understand how GSS supported groups with cognitively similar member styles perform on a creative problem solving process. The specific objectives are as follows:

1. This study will look at the stages in a group's creative problem solving process as per Basadur's SIMPLEX™ model for Creative Problem Solving Process. More specifically, it will look at two creative problem solving stages of divergence or idea generation and convergence or idea selection in order to arrive at a proposed implementation solution. This might give additional insight into the creative problem solving process as well as a more complete representation of the creativity process in groups.
2. Since cognitive style is an important part of an individual's creativity (Amabile,1983), this study will use the Creative Problem Solving Profile (CPSP) inventory to measure cognitive styles for individual group members. This inventory will measure the preference of individuals towards using their knowledge for specific stages in the creative problem-solving process
3. Homogeneous groups will be formed based similar individual member preferences on the CPSP inventory and their performance on the above mentioned stages of divergence and convergence will be observed
4. This study will also measure the performance of the groups on the divergent phase in terms of additional measures of flexibility of ideas and level of elaboration; in addition to the more common variables of fluency (quantity) and originality (uniqueness) to see if significant differences exist.

Specific Research Questions

This research study will address the following research questions.

1. Does creative problem solving preference of members in homogeneous groups impact the creative output of such groups during the divergent phase of the creative problem solving process when GSS is used to facilitate the process?
2. Does creative problem solving preference of members in homogeneous groups impact the creative output of such groups during the convergent phase of the creative problem solving process when GSS is used to facilitate the process?

The above research questions will help researchers and practitioners understand GSS support in context of the creative problem solving process and its relevance to the performance of groups supported by it, when the group members have cognitively similar styles or preferences. More specifically, it will help understand if groups with certain member cognitive styles or preferences gain more benefit from GSS support than groups consisting of members with an alternative style or preference. In the next section, literature related to the relevant areas of the study has been reviewed, thus leading to the propositions and hypotheses related to the research study.

CHAPTER II

REVIEW OF LITERATURE

Broad Overview of the Relevant Research Areas

This study draws from multiple areas of research that are broadly outlined below:

1. Creativity Research that increases understanding of the different creativity related factors relevant to the 4ps of person, product, press (environment) and process.
2. Creative Problem Solving Process Research that primarily looks at the application of creativity to the problem solving area
3. Group Support Systems (GSS) that deals with how a specific type of technology can be used to support groups.

Figure 1 illustrates the focus and the contribution of this study.

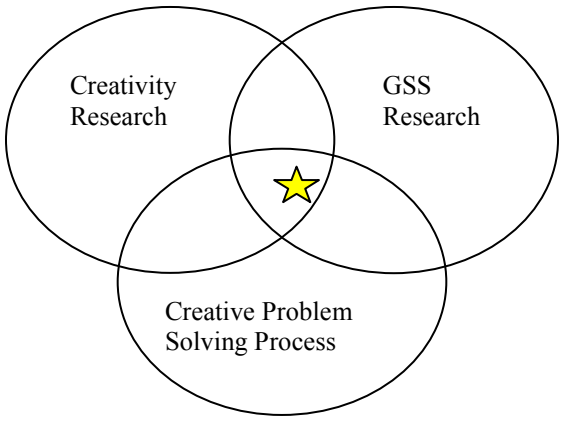

Figure 1. Areas relevant to Research Study

Creativity

In 1950s the then American Psychological Association's President, J.P Guilford (1950) called attention to the neglect of the study of creativity, which spurred a flurry of activity in this area. Since that time much has been accomplished in the area of creativity. It is studied from various perspectives. Stein (1974) suggested that creativity results in generating some novel result, which is useful and different from that which already exists. Bruner (Bruner,1962) focused on creative products that generated a reaction of surprise from the observers.

Some researchers have defined and studied creativity in terms of the 4 Ps, namely Person, Product, Press (environment) and Process (Mackinnon,1970; Murdock et al.,1993).

Most creativity researchers have their own definition creativity. For example, Guilford (1950) defined creativity as abilities that can be found in creative people, emphasizing a "person" approach to creativity. This has been the primary guiding light for empirical research on creativity (Amabile,1996). Thus creativity has been viewed both as a trait of a person and a final product.

Although several models exist that espouse specific characteristics of individuals that lead to creativity, the componential model of creativity (Amabile,1996) has integrated the different dimensions of an individual (personality, knowledge, ability etc.) and is used extensively by researchers as the foundational framework to understand individual creative performance.

Componential Model of Creativity

Amabile (Amabile,1996) asserted that creativity is a process by which a creative product is created. She developed a social psychology theory to understand the social influences

on the creative process. Her model, also known as the componential framework of creativity is as shown in Figure 2.

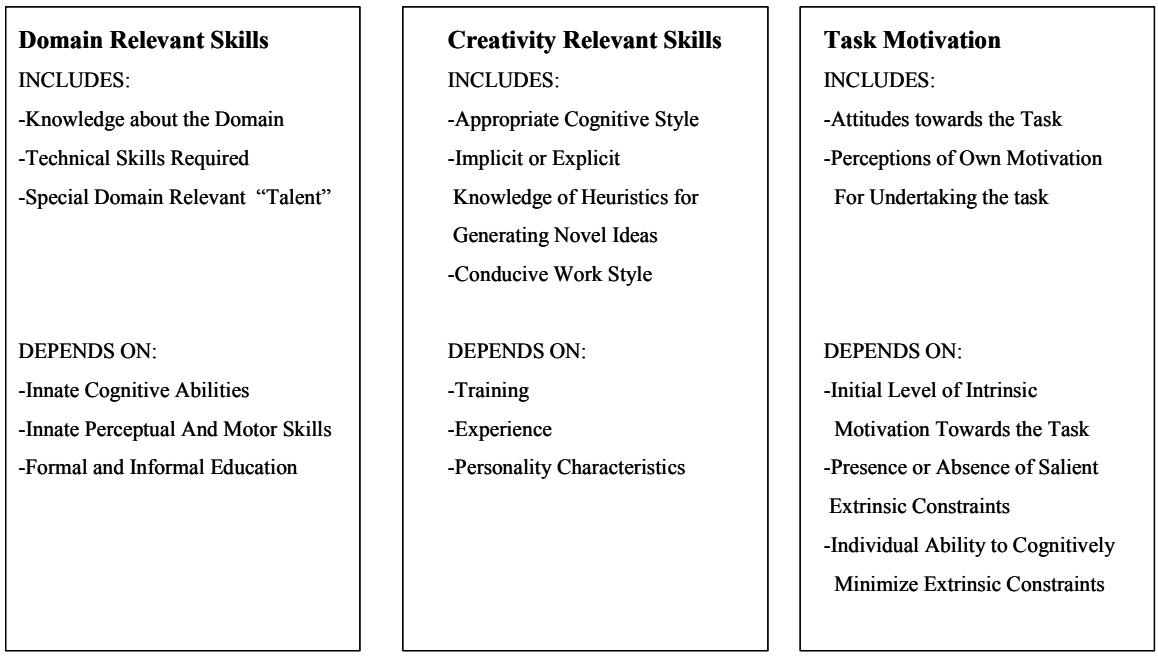

Figure 2. Amabile's Components of Creative Performance (Amabile,1996)

According to Amabile's Componential Model of Creativity, creative performance at the individual level is impacted by three components:

1. **Domain Relevant Skills**: This refers to specific knowledge that an individual holds about the domain or technical skills relevant to the task under consideration.
2. **Creativity Relevant Skills**: This refers to cognitive abilities and personality traits that lead to creative ideas.
3. **Task Motivation**: This refers to an individual's attitude towards performance of the particular task and their interest level.

The creativity relevant skills include cognitive style which is an important component in understanding the members of the groups that will be used in this study. The following

section talks about the application of creativity to the problem solving process and leads into the role of cognitive style in the entire process.

Creative Problem Solving Process

Creativity has also been studied as a process that individuals go through to come up with novel solutions to problems. Study of creativity as a process started with Wallas's (Wallas,1926) Model of creative thinking where he introduced creative thinking as a process with stages of preparation, incubation, illumination and verification in the creativity process. Drawing from Wallas's model, Osborn (Osborn,1953) conceptualized the role of creativity in the problem solving process as the Creative Problem Solving (CPS) process and it consisted of 7 steps including 1) Orientation, 2) Preparation, 3) Analysis, 4) Hypothesis, 5) Incubation, 6) Synthesis and 7) Verification. This was then further modified by Parnes (Parnes,1967; Parnes et al.,1977) and coauthors into a 3-step model: 1) Fact Finding; 2) Idea Finding; and 3) Solution Finding. This model was also known as the Osborn-Parnes Model.

Basadur et al. (1982) extended this model to include 4 basic steps in the problem solving process. This model was called the Simplex™ model, consisting of the following steps:

1. Problem Generating;
2. Problem Formulating;
3. Problem Solving;
4. Solution Implementing.

Although, solution implementation is represented as one of the stages, the SIMPLEX™ process is essentially made up of three main steps of problem generating, formulating and solving. Each of the above stages in the SIMPLEX™ problem solving process is further

divided into two steps, resulting in a total of 8 steps. The SIMPLEX™ creative process as a whole is illustrated in figure 3.

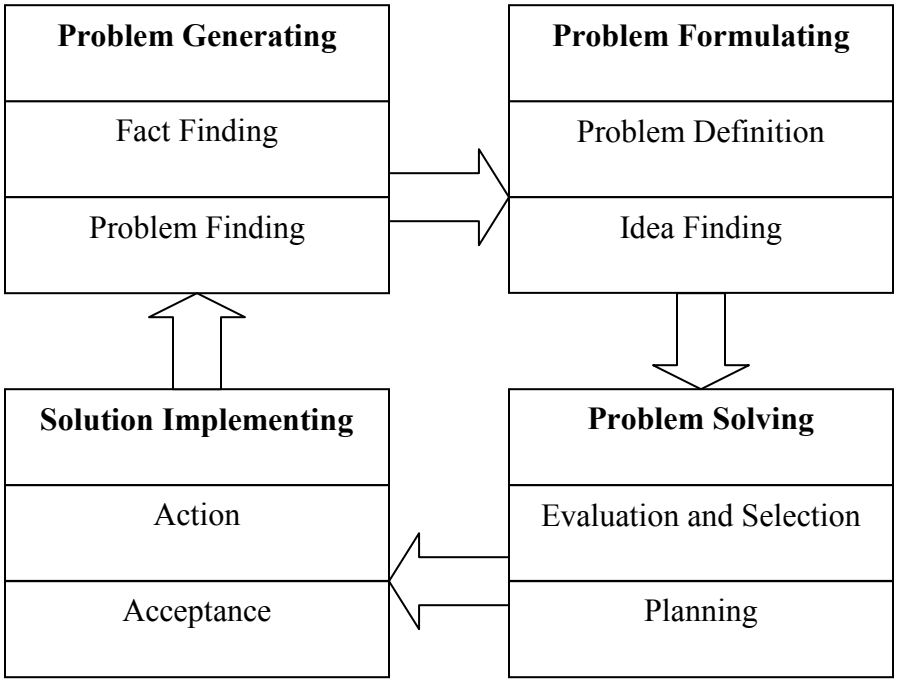

Figure 3. The SIMPLEX™ Creative process (Basadur et al.,2000)

The first step of Problem Generating consists of conceptualizing and trying to discover new and useful problems that need to be addressed within the organization. Problem Formulation is the next step in the process where problem focus is understood and various ideas are generated to solve the problem the team is focused on solving. At the Problem solving step, all the ideas generated in the step before are evaluated with respect to feasibility and criteria laid down by the organization or the team. One idea is selected at this stage as the best alternative solution. In the Solution Implementing stage, this idea is then sold to the entire organization or the individuals that will be impacted for acceptance and finally implemented.

Although all four stages of the process are equally relevant, the two stages of Problem Formulation that include the idea finding or idea generation stage and the Problem Solving stage that includes evaluation and selection will be used for the purpose of this research study. Thus, this study will primarily look at 2 stages associated with the creative problem solving process.

Ideation is the act of divergence which is the process of generating ideas (also known as the divergent phase) and Evaluation is the act of convergence, where judgment is applied to select the best option (also known as the convergent phase) are both equally important(Parnes et al.,1977). For solving problems creatively, one uses their knowledge on hand, and transforms them by imaginative or creative thinking into ideas, options or points of view. These ideas are then evaluated by exercising judgment to select the most appropriate option (Basadur et al.,1990). Thus, any complete creative process should employ both divergent (ideate) as well as convergent (evaluate) thinking (Basadur et al.,2000). Figure 4 illustrates the thinking characteristics at each of the two phases. When in the ideation phase, individuals need to think imaginatively, aiming for more quantity of ideas. In the evaluation phase, individuals need to be judgmental and think about the quality of the overall solution.

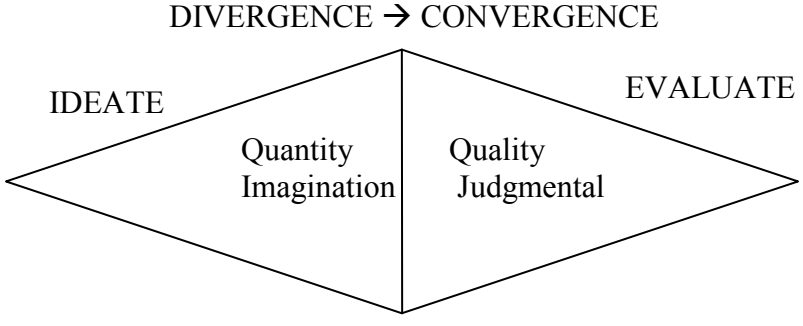

Figure 4. The divergent and convergent phases (Basadur et al.,2000)

Individuals can have cognitive styles that favor a particular phase or mode in which creativity can be applied to the creative problem solving process. The following paragraphs discuss cognitive styles and their relevance to the creative problem solving process.

Cognitive Styles

Various theories were proposed on the cognitive style construct including the most common ones like Field Dependence-Independence theory (Witkin et al.,1981), Reflectivity-Impulsivity (Kagan et al.,1964), Assimilators and Explorers (Kaufmann,1979) as well as Adaptors-Innovators (Kirton,1976) etc.

Basadur and Gelade (Basadur et al.,2005) recently introduced a theory which modeled applied creativity as a cognitive process. According to them, applying creativity is multi-step activity that can be understood in terms of two distinct cognitive processes:

1. Apprehension: Acquisition of knowledge or how individuals gain knowledge: this consists of two opposite ways of gaining knowledge. One is via direct, concrete experience while the other is via abstract thinking;
2. Utilization: Application of the knowledge or how individuals use knowledge: this consists of knowledge use for ideation or divergence at one end and knowledge use for convergence or evaluation at the other end.

The two cognitive processes operate in two modes, resulting in four cognitive orientations that limit the conceptual space of creative activity. These four orientations have been shown in Figure 5.

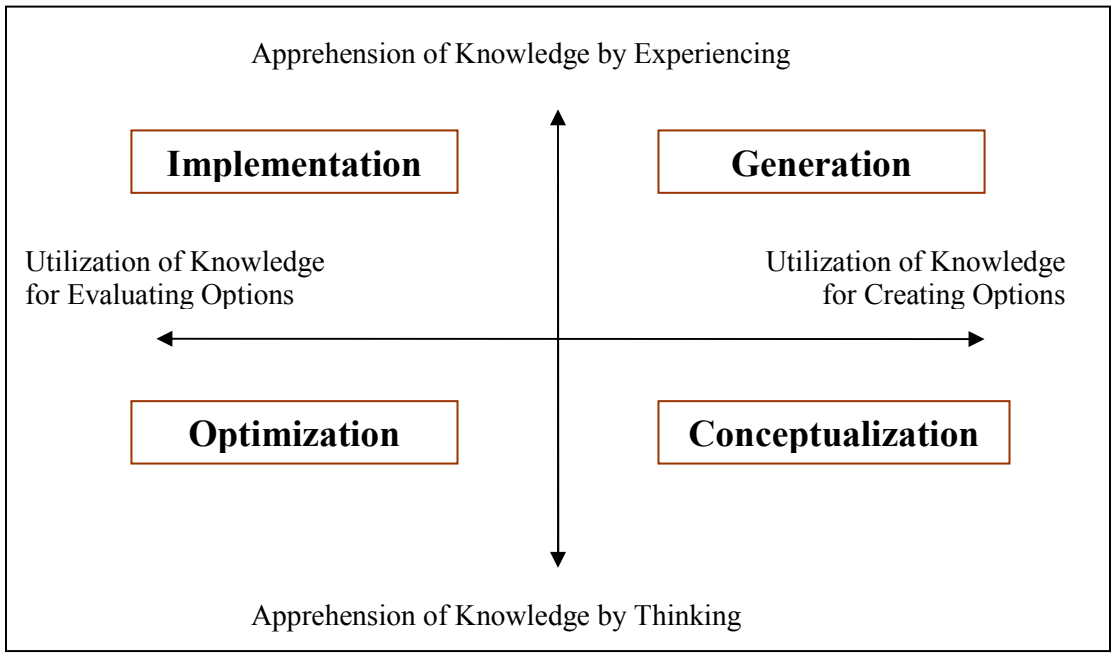

Figure 5. Four Combinations of Gaining and Using Knowledge (Basadur et al.,2005)

Basadur and Head (2001) called for research to examine the use of group support systems (GSS) to facilitate teams that were constructed using the above model. This study considers the "Utilization of Knowledge" dimension to classify individuals into homogeneous groups consisting of people with specific preference for knowledge utilization in order to understand how GSS can be used to facilitate teams with specific cognitive styles (knowledge utilization preference). In order to be able to measure individual preference for each of the modes in Figure 5, the Creative Problem Solving Inventory also known as the Creative Problem Solving Profile (CPSP) was developed.

Basadur et al. (1990) and colleagues developed the Creative Problem Solving Profile Inventory (CPSP) to measure every individual's blend of preferences on the four combinations of gaining and using knowledge during the creative problem solving process. They (Basadur et al.,1990) asserted that each individual can be characterized as having a unique set of preferences on the two knowledge processing dimensions

(experiencing-thinking and ideation-evaluation). These two dimensions could then be used to form four quadrants where each quadrant was a combination of the two dimensions of knowledge apprehension and knowledge utilization (see Figure 4).

A quadrant 1 orientation individual was called a Generator. When in the dominant generator mode, individuals prefer to gain knowledge via concrete experience and prefer to use their knowledge for ideation. They try to imagine possibilities and see relevance in everything by seeing different points of view.

A quadrant 2 orientation individual in the creative problem solving process was called a Conceptualizer. This individual prefers to gain knowledge via abstract thinking and use this knowledge for ideation purposes. They like to see the big picture and extract the essence of ideas to solve the problem.

A quadrant 3 orientation individual was called an Optimizer. This individual prefers to gain knowledge via abstract thinking while using the knowledge for evaluation purposes, like thinking about criteria to assess alternatives. They are more oriented toward problem solving than the other three types.

A quadrant 4 individual was called an Implementor. This individual gains knowledge via direct and concrete experience and uses this knowledge for evaluation purposes. They show a preference for working towards the implementation of solutions to make sure they work and adapt methods to solve problems.

Although how individuals gain knowledge is an important facet of the creative style, it is equally important to understand how individuals use knowledge for generating solutions as well as choosing solutions when involved in a creative problem solving process. Hence for the purpose of this study, the four quadrants were converted into two profiles based

on the knowledge utilization dimension. If groups were formed only on the basis of preference for knowledge utilization (ideation or evaluation) during the creative problem solving process, the two groups would consist of:

1. Ideators : Consisting of Generators and Conceptualizers who have a preference for using knowledge for ideation; and
2. Evaluators: Consisting of Optimizers and Implementors who have a preference for using knowledge for evaluation

Looking at the four profiles it is seen that preference for using knowledge as well as gaining knowledge in a specific way may be more favorable at different stages of the creative problem solving process than others. Until now all preferences were discussed at the individual level. How such an individual level preference might impact a group's creative problem solving process is explained in the next section.

From Individual to Group Creativity

Groups are composed of individuals; therefore much of the group's creative output is influenced by its member's characteristics. Woodman and his colleagues noted "*Individual Creativity, in turn contributes to creativity in groups*"-(Woodman et al.,1993). Individual creativity and group creativity are strongly linked to each other because the process of group creativity starts with individuals within the group conceptualizing ideas and then deciding on whether to share it with the team or not (Gilson et al.,2004). In addition to individual creative characteristics, group's creativity is also influenced by many other factors including group composition, group characteristics, group processes as well as contextual influences (Taggar,2001; Woodman et al.,1993).

Thus the benefits that can be gleaned from group interaction depend on different social, contextual as well as group influences.

Sometimes ideas or comments suggested might stimulate group members to elaborate and suggest additional novel or different ideas and comments (Paulus et al.,1993; Paulus et al.,2000). However, all individuals are not equally stimulated by group interaction (Paulus,2000). Some cognitive styles may be better at generating ideas and will suggest ideas that are remote and unique. Such styles will be very productive in an idea-generation session (divergent phase). The divergent phase involves generating alternatives and thus will be more suited to individuals within this group. Individual preference for using knowledge for ideation will lead to members within the group generating more and different ideas. These ideas will lead to cognitive stimulation (idea triggering) activating related concepts and categories resulting in more ideas generated (Paulus,2000; Taggar,2001).

An important influence on a team's performance is also whether or not a shared mental model exists among any of its members. Shared mental models help individual members within the team to anticipate reactions of other members in the group and also adjust their behavior accordingly (Mumford et al.,2001). Among all the factors, those that impact the coordination among members are the most important influence on a team's performance (Hackman,1990; Mcintyre et al.,1995). Since groups of members with similar preferences will share similar mental models in terms of their preference for knowledge utilization, they will be better equipped to anticipate each other's behaviors resulting in smoother and more implicit coordination within the group.

Also member participation is found to significantly enhance group productivity (Gilson et al.,2004). Individuals with knowledge utilization preference for evaluation may have a tendency to evaluate ideas provided by other members during the divergent phase. The may give negative feedback causing other members to think and self-evaluate their own ideas before sharing it with the group. This will cause individual members to contribute fewer ideas overall and lower participation in the phase for generating ideas.

This reduction in the participation of group members will cause the performance of the groups consisting of individuals with preference for idea evaluation to drop relative to groups with a preference for ideation.

Impact of the above factors on the Ideator and Evaluator groups

Ideator groups prefer to use knowledge to generate more/new ideas and will perform better during the divergent phase of a creative problem solving process than the convergent phase. Shared mental models as well as increased implicit coordination will result in Ideator groups performing well on the divergent phase of the creative problem solving task.

However, the idea evaluation or convergent phase might pose a significant challenge for the Ideator groups since each individual member within the group will have a tendency to generate more ideas instead of trying to narrow down the current set of generated ideas to a few good solutions and eventually select one best option. As a result, converging to a narrow set of good solutions will take much more effort or time for these groups.

Evaluator groups prefer to use knowledge utilization for evaluation purposes and may not be as productive during the divergent phase, since these members will have a tendency to

evaluate the ideas that are being generated. They may simultaneously evaluate the ideas that they are generating and not contribute to the current group goal of ideation because they may not find an idea good enough. Thus they may spend time self-evaluating it rather than contributing it to the group or elaborating on it and generating more new ideas. However, they will perform better during the convergent phase of a creative problem solving process than in the divergent phase. The convergent phase involves evaluating the alternatives or options generated to select ideas that are practical and can be evaluated and hence will be more suited to such groups. Judging the quality as well as feasibility of the different solutions and picking good quality solutions will be relatively easier for them compared to groups where the members all prefer ideation. Thus the knowledge utilization preference of individual team members will impact how a team interacts as well as the processes that a team undergoes. In the next section we review the GSS literature to examine how technology could be used to facilitate group creativity for the groups formed based on knowledge utilization preference as discussed above.

Creativity Research in GSS

Advancements in technology led to the development of GSS to support group level tasks. GSS use resulted in several benefits including: increased efficiency, effectiveness and greater satisfaction with the process when compared to manual groups (Gallupe et al.,1992; Martz et al.,1992; Nunamaker et al.,1991). Creative problem solving was one specific process in the range of group tasks that could be supported by GSS. Since brainstorming is the first phase of the creative problem solving process (divergent phase), the next section reviews some theory on brainstorming.

Brainstorming

Creative idea generation using face-to-face or group brainstorming was first proposed by Osborn(Osborn,1957). He proposed that if members of a group generated ideas without evaluating them, the group could generate more and better ideas than individuals. Members of the group could build on each other's ideas leading to generation of more ideas. Listening to ideas of other members would provide stimulation leading to greater quantity and quality of ideas (Osborn,1957).

Osborn's brainstorming theory was subsequently challenged by many researchers, who found that the nominal groups (in which individuals brainstormed alone) performed better than the face-to-face groups (in which individuals brainstormed together) (Diehl et al.,1987; Diehl et al.,1991; Lamm et al.,1973; Mullen et al.,1991).

Diehl and Stroebe (Diehl et al.,1987) outlined three major reasons for loss of productivity in face-to-face brainstorming groups:

1. Production Blocking: refers to the loss of ideas that occurs when individuals are forced to listen to other's ideas causing distraction and forgetting their own ideas;
2. Evaluation Apprehension: refers to the individual's fear of being criticized by the members of the group, leading to unwillingness to share ideas;
3. Free riding or Social Loafing: refers to the tendency of an individual to ride on ideas of others and not put in much effort since the group results are pooled and evaluated.

Other process losses associated with group brainstorming are also mentioned. Barki & Pinsonneault (2001) extensively reviewed process losses and gains associated with brainstorming and mentioned negative quality matching, social monitoring,

personalization of issues etc. as additional process losses associated with brainstorming approaches.

Electronic Brainstorming

In an effort to minimize some of the process losses associated with the face-to-face brainstorming technique for groups, the electronic brainstorming (EBS) method was proposed (Gallupe et al.,1991). In EBS sessions, individuals pooled their ideas anonymously and synchronously using computers connected by a network. Evaluation apprehension was reduced through anonymity, because ideas were not identifiable with individuals. This helped individuals contribute poorly developed or risky ideas without worrying about negative repercussions from peers or superiors (Connolly et al.,1990; Dennis et al.,1991).

However, social loafing or free riding could still be an issue in EBS sessions. This could be because anonymity tends to promote social loafing. Due to anonymity, individuals would tend to exert less effort since their effort could not be identified. Some researchers discussed techniques like social comparison (people match their rate of idea generation to the rate of others around them) as a way to reduce social loafing in brainstorming groups (Paulus et al.,1993). As a result the net benefit from EBS could be the net of the two opposing effects of anonymity, evaluation apprehension and social loafing (Shepherd et al.,1995).

Even though many process losses were identified, researchers demonstrated that production blocking was the largest process loss associated with face-to-face groups (Diehl et al.,1987; Diehl et al.,1991).

Benefits of GSS

GSS enabled individuals to simultaneously express their ideas when other team members are working on other ideas. Since individuals could contribute their ideas simultaneously and no one had to wait for their turn to speak, production blocking could be eliminated (Shepherd et al.,1995). The electronic medium could be used to alleviate production blocking associated with face-to-face groups and yet provide a medium for interaction between individuals to add process gains (Barki et al.,2001). This could help groups achieve better results. The above literature review leads us to conclude that GSS can be used during the creative problem solving process to facilitate groups in the divergent phase through process gains.

In the next section, the propositions and hypotheses based on the above literature review will be outlined and a research model will be presented.

Proposition and Hypotheses

From the above review we can see that groups consisting of individuals with a preference for utilization of knowledge for ideation (Ideator Groups) can benefit from GSS technology during the divergent phase of the creative problem solving process.

During the divergent phase, Ideator groups will many generate ideas due to the previously reviewed interaction gains of cognitive stimulation as well as increased implicit coordination due to shared mental models. Increased performance of the individuals within the groups will positively impact the creativity of the entire group. Anonymity as well as parallel entry will enable individuals within the group to generate ideas as well as build on (elaborate) other member's ideas, providing the benefits of group interaction without the losses associated with face-to-face groups.

Preference for use of knowledge for evaluation will negatively impact the performance of Evaluator groups during the divergent phase. Even though individuals within these groups will have a tendency to evaluate ideas, starting with the idea generation phase and deferring the evaluation phase via the GSS medium will help structure their interaction in a better manner. Thus, GSS will still help such groups by mitigating the process losses associated with a face-to-face interaction and providing a structure for the creative process. However, since these groups members will tend to evaluate the ideas as they being generated, they will not gain as much benefit from cognitive stimulation as the Ideator groups. As a result their performance on the divergent phase will be lower than the Ideator groups.

Based on the theory discussed above and past empirical evidence the following propositions were derived to represent the research questions mentioned on page 9.

P1: Divergent Phase Performance is positively associated with group members' preference for Knowledge Utilization for Ideation.

From this proposition we generated the following Hypotheses for the DIVERGENT phase:

1) H1: Ideator Groups will generate a greater number of business ideas for the empty university space than will Evaluator Groups. (Idea Fluency)
2) H2: Ideator Groups will generate a greater number of categories of business ideas for the empty university space than will Evaluator groups. (Idea Flexibility)
3) H3: Ideator groups will generate a larger number of unique or "less mentioned" business ideas for the empty university space than will Evaluator groups. (Idea Originality)
4) H4: Ideator groups will generate a greater number of comments on business ideas for empty university space through idea elaboration than will Evaluator groups. (Idea Elaboration)

GSS can also be used to provide structure during the convergent phase of the creative problem solving process for groups by providing tools that enable voting, selecting, and linking of ideas as well as providing details on the implementation of ideas. Thus groups supported by GSS can benefit not only during the divergent phase but also during the convergent phase.

Evaluator Groups will be assisted by GSS as well as their preference for evaluating ideas during the convergent phase of the creative problem solving process. Due to their knowledge utilization preference for evaluation, members of the evaluator groups will

efficiently assess the solution space for feasibility and develop explicit details for implementing a particular solution. GSS will not only support by structuring their interaction but also complement their existing style in addition to reducing the process losses that face-to-face groups might incur.

Ideator Groups will also be benefited by GSS during the convergent phase of the creative problem solving process. However, since these groups prefer to generate more ideas, they may continue to generate ideas instead of trying to converge to a solution even though the electronic medium will enable easy voting as well as feasibility analysis. Thus their performance will be lower as compared to the evaluator groups in the convergent phase. Based on this discussion we propose this second proposition:

P2: Convergent Phase Performance is negatively associated with group members' preference for Knowledge Utilization for Ideation.

From this we generated the following Hypotheses for the convergent phase:

5) H5: Evaluator groups will select the business ideas for the empty university space that are more unique and have a higher aggregated average rating of novelty by the judges' panel than will Ideator groups. (Solution Novelty)
6) H6: Evaluator groups will select the business ideas for the empty university space that have a higher aggregate average judge's rating of practicality than will Ideator groups. (Solution Feasibility)
7) H7: Evaluator groups will generate a larger number of implementation comments for the selected business idea for the empty university space than will Ideator groups. (Solution Elaboration)

Thus the broad constructs are illustrated in the theoretical research model as given in Figure 6. The variables used to measure these constructs as well as the measurement model are discussed in the methods section.

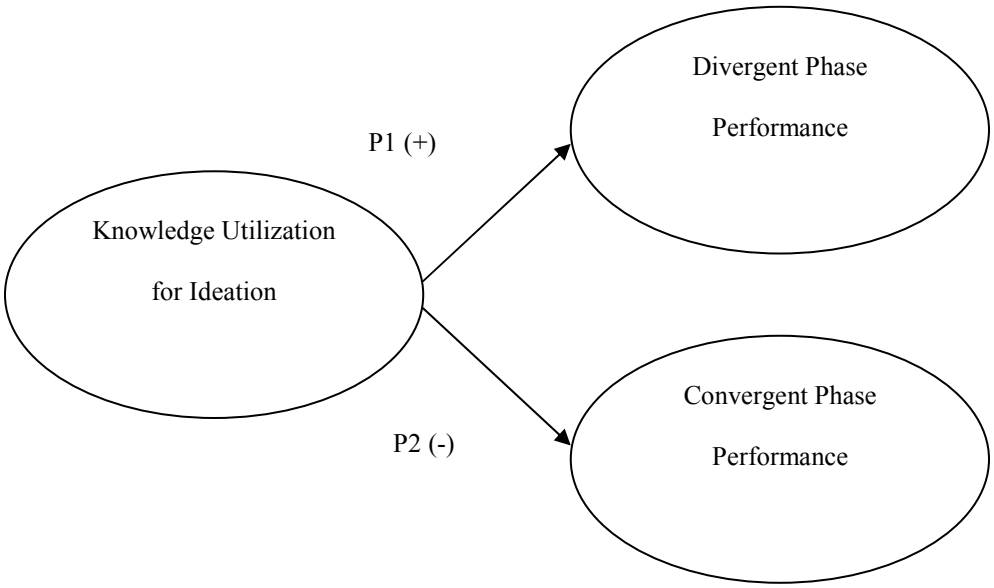

Figure 6. Theoretical Model

The next section will talk about the methodology followed as well as how the constructs for the study were measured.

CHAPTER III

METHODOLOGY

Overview

This section will describe in detail the experimental design, participants, the process followed, the task, the instruments used and the analyses that were used to test the hypotheses presented in the previous section.

Research Design

This study measured the impact of homogeneous group member's knowledge utilization preference for ideation or evaluation on the two phases of creative problem solving process. This was designed as a single factor study, where the main effect or factor was the group member's knowledge utilization preference. Multiple variables were used as indicators of performance of the two groups on the creative problem solving process stages.

Participants

The participants in this experiment were undergraduate students enrolled in business courses at 3000-4000 level at a southwestern university campus. Some students completed this as a part of course credit, while others were recruited and got extra credit point in their class. Since many students enrolled on this campus are non-traditional students, often completing their education while working full time, the average age for this sample was 27.8 years with a range of 20 to 51 years. Work experience values ranged

from 0 years to 31 years, with an average of 8.7 years. The sample was approximately balanced gender-wise with 53.29% females and 46.71% males.

Group formation

To measure preference for utilizing knowledge for ideation, the Creative Problem Solving Inventory (CPSI) developed by Basadur was used. All participants were first required to take the CPSI test online (Refer to Appendix A-1) and the scores for all individuals were delivered as an excel sheet. All participants had scores in each of the four quadrants. Thus the excel sheet gave the scores on preference of individuals for:

1. Using knowledge for Ideation or Evaluation
2. Gaining knowledge through Thinking or Experiencing

Using the excel sheet, profile plots for individuals were plotted. As done in previous studies by Basadur and his colleagues(Basadur et al.,1990; Basadur et al.,2001), dominant quadrants were found for every individual. An example of a profile plot for one of the participants is illustrated in figure 7.

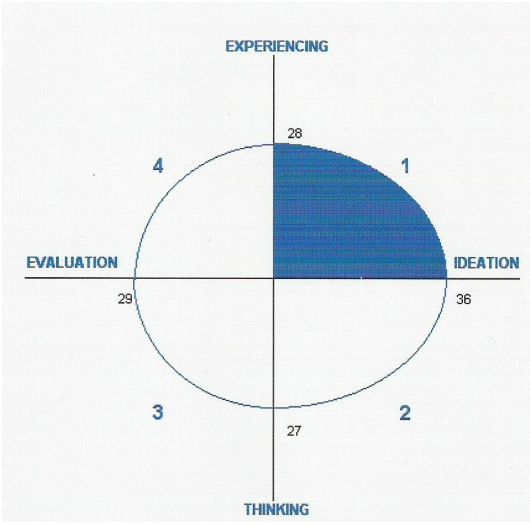

Figure 7. Profile plot for a participant with Generator as the dominant quadrant

Figure 7 represents the profile of an individual with "Generator" as their dominant quadrant. The scores on the two axis for this individual were (28, 27) on the Experiencing-Thinking dimension and (36, 29) on the Ideation-Evaluation dimension. Thus in the Ideation-Evaluation dimension, the more dominant orientation for this individual is to use knowledge for ideation (score of 36) versus the less dominant orientation to use knowledge for evaluation (score of 29).

Since this study was interested primarily in the knowledge utilization dimension, these four quadrants were then combined into two groups depending on the dominant quadrant's position on the knowledge utilization dimension. Thus the "Generators" and "Conceptualizers", who had knowledge utilization preference for ideation, were combined in one group. This group was called "Ideators". Similarly, the "Implementors" and "Optimizers" who had knowledge utilization preference for evaluation were combined into one group. This group was called "Evaluators". Thus Ideator and Evaluator groups were formed where each group consisted of 4 individuals with similar preference for knowledge use. It is important to note here that Basadur and his colleagues (Basadur et al.,1990) found significant results in their study supporting their claims that the distribution of Evaluators ("Implementors and Optimizers") were higher than the Ideators ("Generator and Conceptualizer") dominant styles in business undergraduate population. In their sample there were 69.7% Evaluators and only 30.3% Ideators. In the sample for this study, the ratio was comparatively better. In a total of 180 students who took the survey online, 50 students were found to be Ideators, 106 were classified as evaluators and 24 fell under the unknown category (individuals with equal preference or scores for ideation and evaluation). Thus the ratio in the sample was about 2:1.

Task Specifics

The experimental task was a creative problem solving task which involved generating options and then selecting one of those options as a solution to be implemented. The task started with a divergent phase and then ended with a convergent phase.

We used the University Coffee shop Problem , which has been used in previous studies in the management literature (Goncalo,2004; Goncalo et al.,2006). This task was primarily used due to it's independence from need for domain level knowledge as well as the fact that it was highly relevant to students on this particular campus. Relevancy of task to the subjects is an important issue, since it promotes greater involvement and also helps individuals draw on their personal knowledge and experience (Connolly et al.,1990). For a detailed description of the task, refer to Appendix A-2.

Solving the University Coffee Shop problem creatively consisted of two phases:

1) Divergent Phase: During this phase, individuals were asked to generate as many as possible alternatives for businesses that could be opened up in the empty space within the university.
2) Convergent Phase: During this phase, individuals were asked to rate the ideas generated individually on novelty, feasibility and cost-effectiveness. The idea with the highest aggregate average rated was selected and the group was asked to elaborate on the steps needed to implement the solution.

In the next paragraph, the experimental procedure followed during the study has been outlined.

Experimental Procedure

When students arrived for the experiment, the following steps were followed. First, for every team member that arrived, their names were checked to see if consent forms for participation had been signed as per IRB regulations. Next they were randomly seated such that all team members were seated away from their group members. Once all group members had arrived, the experimental process was started. For groups whose members did not show up, the groups were run with inadequate number of members and consequently dropped from the study. This was to ensure that all students had the opportunity to participate in the study, even if the data from their group had to be dropped.

A script was followed for the purpose of ensuring fairness in the delivery of instructions as well as content for all groups. For details please refer to Appendix A-4. The script started out by pointing out the official task had started and explaining the rules of the lab. Also brainstorming rules according to Osborn (Osborn,1957) were explained to all individuals in the lab and a hardcopy of those rules was also given to all participants. This was important so that the group brainstorming process was carried out smoothly and efficiently. The rules were as follows:

1) Criticism is ruled out. No judgment should be passed on the ideas shared. Remember there is not such thing as a bad idea. All ideas are welcome, even if they may sound crazy and whimsical and totally offbeat.
2) Freewheeling is more than welcome. Feel free to piggy back on others ideas, since the ideas belong to the entire team. The wilder the idea the better it is. Remember it is much easier to tame down than to think up.

3) Generate as many ideas as possible. The more the merrier.
4) Combinations and improvements are important. So in addition to sharing your idea, it would be great to actually help turn the team's pool of ideas into better ideas by elaborating and commenting on them to make them better.

After the students had read through the rules, they were then given a short training on how to use the GSS software "Think-Tank" using a practice task to familiarize them with the software. The practice task involved generating alternate uses for a rock. Once they had generated multiple ideas, the participants were also guided through a mock idea evaluation process using the software, where they rated ideas on predefined criteria. This was done in the exact order in which the actual task was going to be done. The practice session lasted about 10 minutes. Once all individuals were comfortable with the software, the actual task was started. The actual problem solving activity was divided into phases with time allotted for each phase. The following phases and times were strictly followed:

a. Start with idea generation for 15 minutes; additional 5 minutes were given with specific instructions on using this time for elaborating on the existing ideas.
b. Idea rating using pre-defined criteria for10 minutes. The idea with the highest aggregated average rating was selected as the idea chosen for the group.
c. Final Idea elaboration with specific instructions to come up with steps for implementing this idea for 10 minutes

After this point, all participants were instructed to stop typing and were asked to fill out a post-session survey (for details refer to Appendix-3) that measured evaluation

apprehension and production blocking on a 5-point Likert-type Scale as well some open ended questions on the group process and software used. Since individual creativity for all members may be different, Gough's Adjective Checklist (Gough,1979) was also used for measuring individual creative personality.

For example, the output for one of the groups has been shown in Table 1.

Evaluate all options				
Criteria:	**Novelty**	**Feasibility**	**Cost Effective**	**Average**
Ballot Items				
day care	4.5	4.2	3.8	4.2
Study Hall	2.0	4.0	4.8	3.6
oxygen bar	3.8	3.8	3.2	3.6
relaxation room with water fountain	4.0	3.5	3.0	3.5
internet cafe	3.0	3.5	3.8	3.4
AAA	3.8	3.2	3.2	3.4
star bucks	3.5	3.2	3.2	3.3
Panera bread company	3.2	3.5	3.2	3.3
used book exchange room	2.5	3.5	4.0	3.3
a lounge that can accommodate sleeping students	3.5	2.8	3.2	3.2
Activity Room (Games, etc.)	3.2	3.2	3.2	3.2
Massage Parlor	3.8	2.8	3.0	3.2
Discount Book Store	3.5	3.0	3.2	3.2
Online Job application and interview room	1.5	3.2	4.5	3.1
a place to film a reality series on OSU students	3.5	3.0	2.5	3.0
soup kitchen	2.8	2.8	3.2	2.9
Bar	3.0	2.2	3.0	2.8
night club w/alcohol	3.2	2.5	2.8	2.8
culinary classes where the food is sold to students	3.2	1.8	3.2	2.8
spa	2.8	2.8	2.5	2.7
Tutoring resource room	1.8	2.8	3.5	2.7
Rent a note book computer facility	2.2	2.5	3.2	2.7
slot machines	3.0	2.5	2.5	2.7
video game room	2.5	2.8	2.5	2.6
Fast food restaurant	1.8	3.0	3.0	2.6
yoga room	2.0	2.8	3.0	2.6
church	2.5	2.8	2.5	2.6
Taco bueno	2.2	2.5	2.8	2.5
Taco Bell	2.2	2.5	2.8	2.5
hallmark	2.8	2.5	2.2	2.5
retail electronics store	2.2	3.0	2.2	2.5
Italian Restaurant	2.5	2.2	2.2	2.3
speed dating	2.2	2.2	2.5	2.3
hair salon	2.2	1.8	2.8	2.2
strip club	2.8	1.8	2.2	2.2
movie rentals	1.5	2.5	2.8	2.2
boxing gym	3.0	1.5	1.8	2.1
express store	2.5	2.2	1.5	2.1
shoe shop	1.8	2.5	2.0	2.1
paint ball	2.8	1.8	1.5	2.0
Pizza	1.2	2.5	2.2	2.0
dress shop	1.2	2.5	2.2	2.0

movie theater	2.2	2.0	1.8	2.0
dance club	2.5	1.8	1.8	2.0
sleep study	2.2	1.5	1.5	1.8
exercise room	1.5	2.2	1.5	1.8
pet store	2.0	1.5	1.5	1.7
disco club	2.0	1.5	1.5	1.7
roller skating rink	2.0	1.5	1.2	1.6
petting zoo	2.0	1.0	1.0	1.3

Table 1. Output of a group after the idea generation and voting phase.

For the group output in table 1, the idea selected for solution elaboration phase would be the idea with the highest aggregated average on all three criteria of novelty, feasibility and cost-effectiveness. As seen from Table 1, the best rated idea was "Day care" with highest average rating of 4.2 in a scale of 1 to 5. Outputs like these were used for each group that participated in the experiment and their creative output was also measured in terms of the dependant variables explained below.

Dependant Variables

The dependant variables in the study included: quantity of ideas (fluency); flexibility of ideas; originality of ideas; and a count of comments (elaboration) on the ideas that helped define or elaborate the ideas of a group.

This way to measure creativity was defined by Guilford (Guilford,1950) who explained that creative ability could be measured in terms of factors that include:

- **Fluency**: refers to the amount or number of ideas that the person can generate
- **Flexibility**: refers to a change in the direction of thinking
- **Originality**: refers to the novelty or uniqueness of the ideas produced
- **Elaboration**: refers to the ability of the person to present more details or specifics to the ideas generated resulting in more ideas.

This concept of individual level measurement was extended in this study to measure the creative group's output. Thus the group's creative output was measured in terms of the four criteria of fluency, flexibility, novelty and elaboration established by Guilford. This allowed measurement of the ideas generated in the first step of the creative process (divergent phase) not only in terms of quantity (fluency) and quality (originality) but also flexibility and in terms of how many comments were made to elaborate on the suggested ideas.

Thus the following variables were measured for each group in the divergent phase

1) Idea Fluency was measured by counting the total number of ideas generated by the groups, after eliminating redundant or duplicate ideas if any. Thus idea fluency in this study basically refers to the count of total number of non-redundant ideas for each group. This was consistent with the previous studies in the brainstorming research area (Gallupe et al.,1992; Garfield et al.,2001) .
2) Idea Flexibility was scored by looking at the number of unique idea categories suggested. For initial categorization of the ideas, the entire list of ideas was analyzed with great details a list of broad categories were outlined. These categories (Apparel, Arts-related services, Automobile related services, Beauty Related services , Stores, Food, Drink, Health Services, Financial Services, Educational Services, Daily use services, Recreational ideas, Relaxation ideas, Sports related ideas, Stores, Study related ideas and Technology related ideas) were then given to two independent coders along with the final list of 186 ideas. Due to resource constraints, only two coders coded all the ideas into various categories. Some ideas could not be classified into categories and were not

included in the analysis. The inter-coder reliability was calculated and found to be 0.95. The average ideas in the unclassified category were compared for both groups and were found to be approximately same.

3) Idea Originality was measured as the infrequency of the particular idea generated as compared to the range of ideas generated. So if a particular idea was mentioned by only one participant or group, it was to be rated as highly original whereas an idea mentioned by many participants or groups was rated low on originality. Previous studies have used this measure by coding the frequency of idea occurrences and using this as the originality measure (Dennis et al.,1997). After counting the number of times a particular idea had been mentioned, only those ideas were selected as highly original which was mentioned 1, 2 or 3 times. Idea Originality for a group was then determined by measuring the number of highly novel ideas that was suggested by each group. .
4) Idea Elaboration was measured by looking and coding the number of comments that were generated to elaborate on a previous idea. Irrelevant comments not related to any ideas were eliminated from the solution. This measure was based directly on Guilford's definition of the creative ability measurement of elaboration.

During the convergent phase of the creative process, the group's output is a selected solution that can be implemented. Here it was important to assess the quality of the final solution in terms of it's novelty as well as practicality.

One of the most widely used techniques of creativity assessment is Amabile's (Amabile,1982) consensual assessment technique, which involves a panel of judges that

rate the creativity of the output. In this study the consensual assessment technique employed faculty judges with knowledge and background in the creativity literature as well as student judges familiar with the campus and relevant problem to judge the creative output of groups on the basis of Novelty (or Newness) as well as feasibility of the generated ideas. All judges' scores were then aggregated and averaged to get one score on the particular solution idea's quality on the above criteria. The number of comments that were made to improve the final quality of the solution was also important to measure.

Thus the following variables were measured for each group in the convergent phase

1) Solution Elaboration was measured by looking at the final idea picked and the number of comments that were generated to make this one idea into a workable solution.
2) Solution Feasibility was measured by averaging the aggregated panel of judges' rating for the selected idea for each of the groups.
3) Solution Novelty was measured by averaging the aggregated panel of judges' rating on novelty for the selected idea for each of the groups.

Thus the measurement model can be outlined as follows:

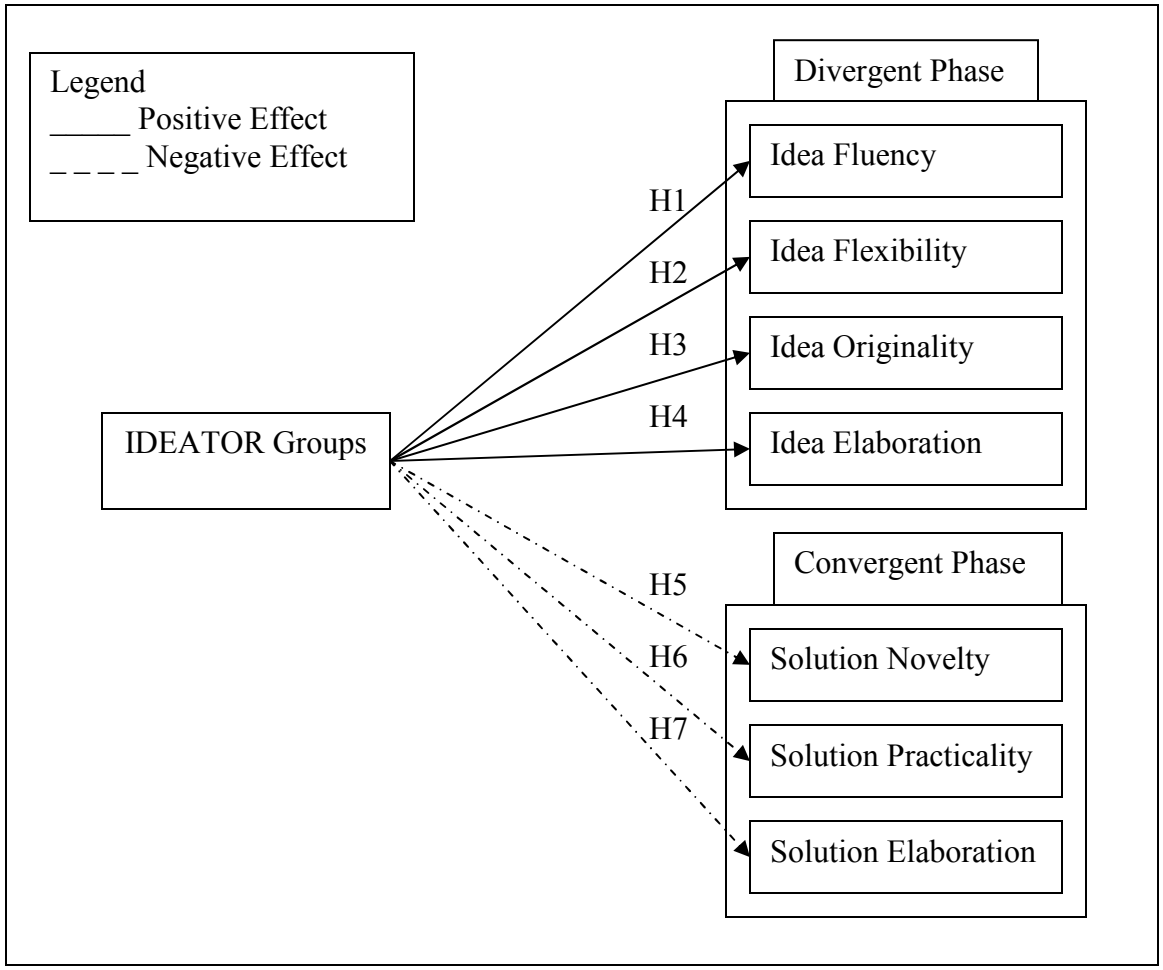

Figure 8. Measurement Model for the study

Analysis

Factor Analysis and Reliability analysis was performed on the post session survey items in order to make sure that all items on the survey had adequate reliability and validity. A covariate analysis is used to eliminate some of the systematic error that cannot be controlled by the researcher as well as to account for some variances in the responses due to unique characteristics of the respondents (Hair et al.,1998).

As mentioned in the literature review, individual creative personality is an important factor in determining an individual's creative ability and will play a significant role in determining the group's creative output. Hence individual creative personality was

measured using a questionnaire adapted from Gough's Adjective Checklist (Gough,1979). Since Evaluation Apprehension and Production blocking are related to the group climate and can impact the group's productivity during the process of idea generation as well as idea selection, these two factors were measured as well. Evaluation Apprehension, Production Blocking and Individual creative personality were each measured with a post-session survey. All three variables were to be used as a covariate in the analysis.

Since at each phase of the creative problem solving process, multiple output variables were measured, Multiple Analysis of Covariance (MANCOVA) was to be used to assess whether or not significant differences existed between the two groups. Thus, at the end of the divergent phase, MANCOVA was to be used to discern if significant differences exist between the two groups (Ideators and Evaluators) on quantity of ideas, flexibility, originality and idea elaboration. For the convergent phase, MANCOVA was to be used to discern if significant differences existed between the two groups (Ideators and Evaluators) on judges rating of solution novelty, solution feasibility as well as solution elaboration of the converged solution. Assumptions of MANCOVA include normality of variables, homogeneity of error variances across groups, equality of variance-covariance matrix for both groups and independence of error terms. All these assumptions were checked for and transformations were performed if violations existed to correct it. Analysis was performed only after all assumptions had been met satisfactorily.

In the following sections, results of the analysis will be presented, which will be followed by a detailed discussion on the significance of the findings.

CHAPTER IV

RESULTS

In this section, diagnostic measures taken before the analysis as well as the results of the analysis are presented.

Summary of Results

The results from the analyses have been summarized in Tables 1 and 2 below.

Dependant Variable	Group Type	Mean	F-Statistic	Eta-Squared	Hypothesis
Idea Fluency	Ideators	36.1667	6.43	0.172	H1 supported
	Evaluators	27.8421			
Idea Originality	Ideators	16.33	9.65	0.236	H2 supported
	Evaluators	13.36			
Idea Flexibility	Ideators	8.66	7.30	0.179	H3 supported
	Evaluators	4.26			
Idea Elaboration	Not included in the model			Homogeneity of variance violation	Not Tested

Table 2. Results for the Divergent Phase

Dependant Variable	Group Type	Mean	F-statistic	Hypothesis
Solution Comments	Ideators	26.33	.751	H5 Not Supported
	Evaluators	24.26		
Solution Novelty	Ideators	2.85	4.320	H6 Not Supported
	Evaluators	2.40		
Solution Feasibility	Ideators	5.08	3.487	H7 Not Supported
	Evaluators	7.179		

Table 3. Results for the Convergent Phase

Reliability and Exploratory Factor Analysis (EFA)

Reliability analysis as well as exploratory factor analyses was performed to validate items from the survey that measured evaluation apprehension and production blocking. One of the items measuring production blocking did not load as expected on the factor analysis and was consequently dropped. One of the evaluation apprehension items was also dropped for better reliability and a clearer factor rotation. The final EFA results are outlined in tables 4 and 5.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.811
Bartlett's Test of Sphericity	Approx. Chi-Square	370.669
	df	21
	Sig.	.000

Table 4. KMO and Bartlett's Test of Sphericity

The Kaiser-Meyer-Olkin measure of sampling adequacy and the Bartlett's Test of Sphericity test the appropriateness of using factor analysis for the data under consideration. These measures give an indication of whether the data is appropriate and suitable for factor analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.811 while the Bartlett's test of Sphericity was significant at the 0.05 level, making the item pool from the response data suitable for exploratory factor analysis (Hair et al.,1998).

PROMAX rotation is an oblique rotation technique that is used when the factors that are being extracted are expected to have a certain degree of correlation with each other. Pattern Matrix for the rotated solution using PROMAX rotation has been given in Table 2. All loading less that 0.3 were suppressed to provide easy readability. Factor loadings

greater than 0.5 are generally considered to be practically significant (Hair et al.,1998). Loadings basically represent each item and how strongly they capture a particular construct. All items that are measuring a particular construct should load on a single component (which represents the construct) and factor loadings above 0.5 signify that they load adequately.

	Component	
	1	2
EA1	.887	
EA2	.838	
EA3	.677	
EA5	.756	
PB2		.831
PB3		.708
PB4		.856

Table 5. Pattern Matrix using PROMAX rotation

Reliability for Evaluation Apprehension (EA) and the Production Blocking (PB) items in the post-session survey was determined by computing the internal consistency coefficient (Cronbach's alpha). According to Nunnally (1978), values between 0.6-0.8 are acceptable for exploratory research, but values above 0.7 are preferred. The reliability value for the Evaluation Apprehension Scale was 0.79 and for the Production Blocking scale was 0.73 meaning that the instrument was internally consistent and reliable. Factor based scales were formed using the above results. However, the factor based scales for EA and PB were highly correlated with each other (correlation above 0.85); therefore only EA score was scores were used as covariate in the MANCOVA analysis. Results from the divergent (idea generation) phase are presented first.

Divergent Phase MANCOVA Assumptions

Validity of the underlying assumptions for MANCOVA was checked. The assumptions of normality of all the dependant variables, equality of variance-covariance matrices, and independence of error terms were all checked. Also MANCOVA requires that the dependant variables be correlated with one another; this was verified by using the Bartlett's test for Sphericity. The results of all the assumption checks are given in the tables 6 – 10.

	Group Type	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Number of Ideas	0	.210	12	.150	.861	12	.051
	1	.114	19	.200	.935	19	.210
Idea Originality	0	.131	12	.200	.937	12	.464
	1	.213	19	.023	.730	19	.000
Flexibility of Ideas	0	.202	12	.188	.946	12	.574
	1	.158	19	.200	.961	19	.591
Comments on Ideas	0	.200	12	.200	.885	12	.102
	1	.152	19	.200	.912	19	.081

Table 6. Test of Normality for all dependant variables across the two groups

Table 6 reveals that Idea originality had a significant normality statistic for group 1 (evaluator groups), which means Idea originality variable was not distributed normally for that group. According to Hair et al. (1998), data transformations help in correcting violations of statistical assumptions underlying the multivariate techniques. They also state that usually negatively skewed distributions are best transformed by square-root transformation and logarithmic transformations work best on positively skewed distribution, but researchers should apply all transformations and select the one that's the most appropriate. After applying multiple transformations and examining their effect on the distribution, a log transformation was applied to the idea originality variable to

correct the issue of non-normality. Also Number of Ideas was also close to significance and was best transformed using a square root transformation. The normality test with the transformed variables is given in Table 7.

	Group Type	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Number of Ideas (transformed)	Ideators	.183	12	.200	.870	12	.065
	Evaluators	.085	19	.200	.975	19	.872
Flexibility of Ideas	Ideators	.140	12	.200	.962	12	.806
	Evaluators	.149	19	.200	.924	19	.132
Idea Originality	Ideators	.202	12	.188	.946	12	.574
(transformed)	Evaluators	.158	19	.200	.961	19	.591
Comments on Ideas	Ideators	.200	12	.200	.885	12	.102
	Evaluators	.152	19	.200	.912	19	.081

Table 7. Test of Normality after transformation was applied

Residual plots were checked for normality using both P-P plots as well as the above statistical test for normality. First, the standardized and studentized residuals were stored and the normality tests were conducted for the residuals. Only standardized residual normality tests are reported.

	Group Type	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual for Number of Ideas (transformed)	Ideators	.179	12	.200	.960	12	.777
	Evaluators	.167	19	.169	.968	19	.729
Standardized Residual for Idea Originality (transformed)	Ideators	.170	12	.200	.954	12	.692
	Evaluators	.088	19	.200	.974	19	.849
Standardized Residual for Flexibility of Ideas	Ideators	.281	12	.010	.905	12	.186
	Evaluators	.121	19	.200	.967	19	.712
Standardized Residual for Comments on Ideas	Ideators	.145	12	.200	.937	12	.461
	Evaluators	.103	19	.200	.955	19	.481

Table 8. Test of Normality for all DV residuals

As we can see from the table 8, the residual normality statistic for idea flexibility was significantly not normal. Inverse square root transformation best corrected the residual normality issue for idea flexibility variable. The test for normality for all residuals was satisfied and is displayed in table 9.

	Group Type	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual for Number of Ideas (transformed)	Ideators	.179	12	.200	.960	12	.777
	Evaluators	.167	19	.169	.968	19	.729
Standardized Residual for Idea Originality (transformed)	Ideators	.170	12	.200	.954	12	.692
	Evaluators	.088	19	.200	.974	19	.849
Standardized Residual for Flexibility of Ideas (transformed)	Ideators	.222	12	.106	.917	12	.264
	Evaluators	.157	19	.200	.929	19	.169
Standardized Residual for Comments on Ideas	Ideators	.145	12	.200	.937	12	.461
	Evaluators	.103	19	.200	.955	19	.481

Table 9. Test of Normality for all DV residuals with transformations

Residual sequence plots were also checked for independence of error terms. To check for equality of variance across groups, Levenne's test was used (See Table 10.).

Variables		Levene Statistic	df1	df2	Sig.
Number of Ideas (transformed)	Based on Mean	.310	1	29	.992
Idea Originality (transformed)	Based on Mean	.033	1	29	.838
Idea Flexibility (transformed)	Based on Mean	.560	1	29	.417
Comments on Ideas	Based on Mean	15.919	1	29	.001

Table 10. Test of Homogeneity of Variance for DVs

As we can see, the dependant variable "Comments on Ideas" did not satisfy the equality of variance assumption. Numerous transformations like log, square root, and inverse were applied. However, none of the transformations stabilized the variance and restored normality. Hence this variable was dropped from further analysis.

To check for constant variance-covariance matrices across groups as well the correlations between the dependant variables, the Box's-M Test followed up with Levenne's test and the Bartlett's test for Sphericity was also used. The results are given in the tables 11, 12 and 13.

Box's M	9.493
F	1.388
df1	6
df2	3604.654
Sig.	.216

Table 11. Box's M Test for Divergent Phase MANCOVA

Likelihood Ratio	.000
Approx. Chi-Square	220.623
df	5
Sig.	.000

Table 12. Bartlett's Test of Sphericity (Divergent Phase)

	F	df1	df2	Sig.
Number of Ideas (transformed)	.400	1	29	.532
Idea Originality (transformed)	.886	1	29	.354
Idea Flexibility (transformed)	2.244	1	29	.145

Table 13. Levenne's Test of Equality of Error Variances

All underlying assumptions for MANOVA were satisfied by the Divergent Phase data. However since covariates are used in the analysis, some key issues concerning the appropriateness of the covariance model needed to be tested (Kutner et al.,2005).

One of the assumptions of using MANCOVA is that the covariate should be correlated with the dependant variable and not correlated with the independent variable. The reasoning behind it is as follows. A covariate is introduced to explain away some of the

error variance in the dependant variable. The covariate will only explain some part of the variance if it is correlated with the dependant variable. Also, it is important that the covariate is not correlated with the independent variable since then the covariate will impact the effect of the independent variable on the dependant variables thus reducing the chances of detecting an effect. The correlations were checked and this assumption was satisfied (All correlations approximately equal to 0.3 of the covariate with the dependant variables, no correlation with the Independent variable).

Another assumption for covariate analysis deals with homogeneity of regression slopes across both the independent variable groups. When the main effect or treatment interacts with the covariate, resulting in nonparallel slopes, covariance analysis is not appropriate(Kutner et al.,2005). This assumption can be tested in multiple ways. One way of testing it is by calculating the Sum of Squares (SS) for Error for one global MANCOVA as well as Pooled SS for Error (SSE) after running each MANCOVA separately for both the groups. Pooled Residual SS from the two groups is then subtracted from the residual SS of the global model. This is the Mean Residual SS for Global model. Mean Pooled residual SS for the individual models is calculated as Pooled residual SS divided by pooled degrees of freedom. An F statistic is calculated as the ratio of Mean Residual SS for Global model divided by Mean Pooled residual SS. The calculations are shown in tables below.

Source	Dependent Variable	Type III Sum of Squares	df
Error	Idea Fluency	19.476	27
Global	Idea Originality	1.143	27
	Idea Flexibility	.0117	27

Source	Dependent Variable	Type III Sum of Squares	df
Error	Idea Fluency	4.596	9

Group=0	Idea Originality	.058	9
	Idea Flexibility	.004	9
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**
Error	Idea Fluency	12.122	16
Group =1	Idea Originality	.687	16
	Idea Flexibility	.043	16

Table 14. Residual SS for all models

Source	**Dependent Variable**	**Type III Sum of Squares**	**df**
Pooled Residual SS	Idea Fluency	16.718	25
	Idea Originality	0.987	25
	Idea Flexibility	.101	25

Table 15. Pooled Residual SS for the individual models

Source GLOBAL	**Dependent Variable**	**Mean Sum of Squares**	**df**
Mean Residual SS	Idea Fluency	19.476-16.718=2.758	1
	Idea Originality	1.143-0.987=0.156	1
	Idea Flexibility	0.117-.101=0.016	1
Source POOLED	**Dependent Variable**	**Mean Sum of Squares**	**df**
Mean Residual SS	Idea Fluency	16.718/25=0.668	25
	Idea Originality	0.987/25=0.039	25
	Idea Flexibility	.101/25=0.004	25
F Statistic	Idea Fluency	2.758/0.668=4.12	1
	Idea Originality	0.156/0.039=4	1
	Idea Flexibility	0.016/0.004=4	1

Table 16. F Statistic Calculation Table

Thus the F statistic calculated was then compared to the F critical value from the F-distribution table for numerator df=1 and denominator df=25. The value of F-critical statistic with the above degrees of freedom and alpha level of 0.05 was 4.24. The calculated F statistics for all dependant variables were less than 4.24. Thus the homogeneity of regression slope assumption was also satisfied for all of the dependant variables.

An additional technique was use to confirm the results from the above test for homogeneity of regression slope assumption. The test for homogeneity of regression slopes (parallel slopes) is equivalent to a test for no interactions in the generalized model with covariates (Kutner et al.,2005). Here the main factor, "group type" as well as the two covariates (average creative personality score and average EA score for the group), and all two-way and the one three-way interaction effects were introduced into the model, determine whether or not a each particular interaction was significant. None of the interaction effects were significant, which indicates that we can safely assume that homogeneity of regression slopes assumption was satisfied (see Table 17.).

Effect		Value	F	Hypothesis df	Error df	Sig.
GRPTYPE	Pillai's Trace	.067	.503	3.000	21.000	.685
	Wilks' Lambda	.933	.503	3.000	21.000	.685
	Hotelling's Trace	.072	.503	3.000	21.000	.685
CPERSON	Roy's Largest Root	.072	.503	3.000	21.000	.685
	Pillai's Trace	.025	.180	3.000	21.000	.908
	Wilks' Lambda	.975	.180	3.000	21.000	.908
AVGEA	Hotelling's Trace	.026	.180	3.000	21.000	.908
	Roy's Largest Root	.026	.180	3.000	21.000	.908
	Pillai's Trace	.034	.247	3.000	21.000	.863
GRPTYPE * CPERSON	Wilks' Lambda	.966	.247	3.000	21.000	.863
	Hotelling's Trace	.035	.247	3.000	21.000	.863
	Roy's Largest Root	.035	.247	3.000	21.000	.863
GRPTYPE * AVGEA	Pillai's Trace	.088	.678	3.000	21.000	.575
	Wilks' Lambda	.912	.678	3.000	21.000	.575
	Hotelling's Trace	.097	.678	3.000	21.000	.575
GRPTYPE * CPERSON * AVGEA	Roy's Largest Root	.097	.678	3.000	21.000	.575
	Pillai's Trace	.067	.506	3.000	21.000	.683
	Wilks' Lambda	.933	.506	3.000	21.000	.683

Table 17. Multivariate test for testing homogeneity of slope assumption

Once all assumptions required for MANCOVA analysis were met, the actual MANCOVA was run and the results are presented in the following paragraphs.

MANCOVA Results for the Divergent Phase

Results from the MANCOVA for the divergent phase are presented in the tables below (Tables 18 and 19). The variables represented in the tables are as follows

1) CPERSON: Average creative personality score for all members in the group
2) AVGEA: Average of Evaluation Apprehension for all members in the group
3) GRPTYPE: Main effect of Group Type, representing Ideators or Evaluators

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.886	65.028	3.000	25.000	.000
	Wilks' Lambda	.114	65.028	3.000	25.000	.000
	Hotelling's Trace	7.803	65.028	3.000	25.000	.000
	Roy's Largest Root	7.803	65.028	3.000	25.000	.000
CPERSON	Pillai's Trace	.058	.511	3.000	25.000	.678
	Wilks' Lambda	.942	.511	3.000	25.000	.678
	Hotelling's Trace	.061	.511	3.000	25.000	.678
	Roy's Largest Root	.061	.511	3.000	25.000	.678
AVGEA	Pillai's Trace	.171	1.720	3.000	25.000	.189
	Wilks' Lambda	.829	1.720	3.000	25.000	.189
	Hotelling's Trace	.206	1.720	3.000	25.000	.189
	Roy's Largest Root	.206	1.720	3.000	25.000	.189
GRPTYPE	Pillai's Trace	.301	3.582	3.000	25.000	.028
	Wilks' Lambda	.699	3.582	3.000	25.000	.028
	Hotelling's Trace	.430	3.582	3.000	25.000	.028
	Roy's Largest Root	.430	3.582	3.000	25.000	.028

Table 18. Global MANCOVA Analysis results

a Computed using alpha = .05
b Exact statistic
c Design: Intercept+CPERSON+AVGEA+GRPTYPE

From Table 18 we can see that the GRPTYPE was a significant factor. The test of between subjects' effects is given in Table 19.

Source	Dependant Variables	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Group Type	Number of Ideas	4.634	1	4.634	6.43	.017	0.192
	Idea Originality	.409	1	.409	9.65	.004	0.263
	Idea Flexibility	.007	1	.007	7.30	.012	0.213
Error	Number of Ideas	19.476	27	0.721			
	Idea Originality	1.143	27	0.042			
	Idea Flexibility	0.027	27	0.001			
Corrected Total	Number of Ideas	26.913	30				
	Idea Originality	1.727	30				
	Idea Flexibility	0.039	30				

Table 19. Test of Between Subjects Effects (Alpha=0.05)

MANCOVA compared the mean number of ideas, mean idea originality and mean idea flexibility of ideators and evaluators. This test was found to be statistically significant at an alpha level of 0.05, with F and p-values as given in Table 19.

The strength of the relationships as indexed by Eta-squared was calculated using the formula Eta-Squared= SS(between)/SS(total) for each dependant variables. It was 0.172 for number of ideas, 0.236 for idea originality and 0.179 for idea flexibility.

The results from the analysis of data from the convergent phase of the creative problem solving process are presented below. All assumptions required were checked for the set of dependant variables in this phase as well.

Convergent Phase MANCOVA Assumptions

As in the divergent phase, before running the statistical tests, it was important to check for the validity of the underlying assumptions. The assumptions that were checked were normality of all the dependant variables, equality of variance-covariance matrices, and independence of error terms. The results of all the assumption checks are given in the tables below.

	Group Type	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Solution Comments (Elaboration)	Ideators	.200	12	.200	.917	12	.258
	Evaluators	.099	19	.200	.990	19	.998
Solution Novelty	Ideators	.175	12	.200	.933	12	.416
	Evaluators	.172	19	.141	.907	19	.065
Solution Feasibility	Ideators	.211	12	.148	.872	12	.069
	Evaluators	.215	19	.021	.845	19	.005

Table 20. Descriptive Statistics for the Convergent Phase

Table 20 indicates that Solution Feasibility violated the normal distribution assumption. In order to correct this problem, a square transformation was applied to the violating variable. Results after transformation are shown in Table 21.

	Group Type	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Solution Comments	Ideators	.200	12	.200	.917	12	.258
	Evaluators	.099	19	.200	.990	19	.998
Solution Novelty	Ideators	.175	12	.200	.933	12	.416
	Evaluators	.172	19	.141	.907	19	.065
Solution Feasibility	Ideators	.195	12	.200	.904	12	.178
(transformed)	Evaluators	.172	19	.141	.927	19	.152

Table 21. Descriptive Statistics for the transformed variables

Residual plots were also checked for normality using both P-P plots as well as the above statistical test for normality. First, the standardized and studentized residuals were stored and the normality tests were conducted for the residuals. Only standardized residual normality tests are reported for the convergent phase dependant variables in Table 22.

Standardized	Group Type	Kolmogorov-Smirnov			Shapiro-Wilk		
Residuals for		Statistic	df	Sig.	Statistic	df	Sig.
Solution Comments	Ideators	.130	12	.200	.951	12	.655
	Evaluators	.106	19	.200	.985	19	.986
Solution Novelty	Ideators	.192	12	.200	.922	12	.299
	Evaluators	.113	19	.200	.968	19	.726
Solution Feasibility	Ideators	.145	12	.200	.937	12	.456
	Evaluators	.175	19	.126	.935	19	.214

Table 22. Residual Normality tests

To check for equality of variance across groups, Levenne's test was used. The results are given in Table 23.

		Levene Statistic	df1	df2	Sig.
Number of Solution Comments	Based on Mean	1.276	1	29	.268
Solution Feasibility (transformed)	Based on Mean	.018	1	29	.894
Solution Novelty	Based on Mean	1.393	1	29	.247

Table 23. Homogeneity of variance tests for all dependant variables

To check for constant variance-covariance matrices across groups as well the correlations between the dependant variables, the Box's-M Test followed up with Levenne's test and the Bartlett's test for Sphericity was also used. The results are given in the tables 24, 25 and 26 below.

Box's M	4.292
F	.627
df1	6
df2	3604.654
Sig.	.709

Table 24. Box's M Test for Convergent Phase MANCOVA

Likelihood Ratio	.000
Approx. Chi-Square	111.425
Df	5
Sig.	.000

Table 25. Bartlett's Test of Sphericity (Convergent Phase)

	F	df1	df2	Sig.
Number of Solution Comments	1.276	1	29	.268
Solution Novelty	1.393	1	29	.247
Solution Feasibility (transformed)	.018	1	29	.894

Table 26. Levenne's Test of Equality of Error Variances

All underlying assumptions for MANOVA were thus satisfied by the Convergent Phase data as well. Since covariates were to be included in the analysis, correlations of the covariates with the dependant variable were checked. None of the correlations were significant and none of the two covariates were included in the analysis. Hence, for the convergent phase, a MANOVA model was run with "group type" as the main effect. The results from the MANOVA are given in the following tables.

MANOVA Results for the Convergent Phase

For the convergent phase, a MANOVA model was run with "group type" as the main effect. The results from the MANOVA are given in the following tables.

Effect		Value	F	Hypothesis df	Error df	Sig.
GRPTYPE	Pillai's Trace	.157	1.677	3.000	27.000	.195
	Wilks' Lambda	.843	1.677	3.000	27.000	.195

	Hotelling's Trace	.186	1.677	3.000	27.000	.195
	Roy's Largest Root	.186	1.677	3.000	27.000	.195

Table 27. Multivariate tests for the Main effect of GRPTYPE

Source	**Dependant Variables**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**	**Partial Eta Squared**
Group Type	Number of Solution Comments	31.520	1	31.520	.751	.393	.025
	Solution Novelty	1.465	1	1.465	4.320	.047	.130
	Solution Feasibility	32.310	1	32.310	3.487	.072	.107
Error	Number of Solution Comments	1216.35	29	41.943			
	Solution Novelty	9.834	29	.339			
	Solution Feasibility	268.674	29	9.265			
Corrected Total	Number of Solution Comments	1247.87	30				
	Solution Novelty	11.298	30				
	Solution Feasibility	300.984	30				

Table 28. Test of Between Subject Effects (Partial) for GRPTYPE

The MANOVA compared the average solution comments, average solution novelty and average solution feasibility of ideators and evaluators. This test was found to be statistically not significant at an alpha level of 0.05, with F and p-values as given in Table 28. In the next section, the results presented here will be discussed as well as theoretical and practical implications of the results will be analyzed.

CHAPTER V

DISCUSSION AND CONCLUSION

Multiple factors impact any group's performance on a creative problem solving task. Some of these factors are related to the process, like production blocking and evaluation apprehension. Research on EBS have focused on the losses and gains experienced by members within the group and how these factors impact the group's performance on the task. However, the group process can be greatly influenced by the individuals that form the group and their characteristics. Group composition and member characteristics play an important role in determining the group's performance. This study investigated the role of cognitive style based group composition on the performance of the entire group.

Study Findings

The creative problem solving style measured in this study helped explain how individuals use their knowledge when involved in the creative problem solving process. Since Ideators prefer to diverge, it was posited that they would perform better in the divergent phase of the creative problem solving process.

This study found that the ideator groups performed significantly better than their evaluator counterparts on several measures of performance in the idea generation phase. Ideator groups generated a greater number of ideas and a greater variety of categories than the evaluator groups. The ideas generated by the ideator groups were also more

unique or original, which in the context of this study means that their ideas were thought of by fewer than 3 groups, out of the 31 that were included in the study. All findings were statistically significant at an alpha level of 0.05.

However, in the idea elaboration phase ideator and evaluator groups did not perform differently from each other. Performance of the groups was measured on the novelty of the solution selected, the number of solution comments generated and the feasibility of the solution. There were no significant differences among the performance of the two groups on any of the three dependant variables.

There are several possible explanations for this result. It could be that the GSS support enhanced the performance of the Ideator groups more than the Evaluator groups. As a result of this improved performance, Ideator and Evaluator groups performed at par with one another. The non-significant results could also be due to certain limitations of the study like sample size and characteristics or experimental process, that are discussed later in this section.

Contextual factors like importance and relevance of the task to the group can also impact its performance. The groups in this study generated 181 unique ideas, implying that the groups found the task engaging and interesting. The next sections discuss the contributions and implications of this study.

Contributions of the Study

The contributions of this research are multi-fold. First, it enhances the understanding of how groups of members with a particular creative style perform when facilitated by GSS during the creative problem solving process. The study revealed that ideators performed

significantly better than evaluators on the divergent phase of the creative problem solving process, when facilitated by GSS. It was also interesting to note that no significant differences were found between the two groups on the convergent phase even though theory suggests that ideators would perform worse than evaluators during this phase. Although GSS facilitation was used in both the phases of the creative problem solving process, it did not help the evaluator groups as much during the convergent process.

This can imply that the GSS assisted the Ideator groups much more than the Evaluator groups during both the phases of the creative problem solving process. The GSS used, not only provided an anonymous, apprehension-free environment for the idea generation process, but also helped the Ideator groups with preference for generating ideas, structure their interaction during the evaluation phase.

Another contribution of this research study is that it measured brainstorming output in terms of idea flexibility in addition to the constructs of fluency and originality extending the traditional productivity measures of quantity and novelty to a set of more holistic measures that reflects the overall creativity of a group. Using this holistic set of performance measures might explain some of the contradicting results in the EBS literature on group performance in comparison to nominal groups.

This research also examined the performance of GSS supported groups on the creative process as a whole, incorporating the entire problem solving cycle. Most research in the GSS literature for creativity has looked at divergent phase only. Thus an important contribution of this research is that it went beyond the phase of just generating ideas and actually considered the selection and implementation aspects of those ideas as well.

Implications for Research and Practice

The findings of this study suggest that GSS facilitation may improve performance of some creative problem solving styles more than others during specific phases of the creative problem solving process. This has multiple implications for researchers as well as practitioners.

For researchers, the findings suggest that composition of groups is an important factor in a creative problem solving process. Cognitive style or preference could be a potentially important variable that cannot be ignored and should be taken into consideration when performances of GSS supported groups are studied. It should be measured and either controlled for or included as a factor when examining technology-supported group performance.

The results of the study suggest that idea flexibility is an important component of idea generation performance. Hence it should be measured by researchers in order to holistically view the performance measures. This will help researchers to easily compare and consolidate findings across studies and build a cumulative research tradition.

For practitioners, the study gives insight into performance of groups that are supported only via GSS and do not meet face-to-face. Managers need to understand the differences in individual group member cognitive styles within the organization and how it can impact the performance of a GSS supported group. Managers could potentially use these measures and form groups based on these styles to best support their task on hand.

For example, managers can look at profiles for various employees and form groups that contain individuals with preference for ideation during the first phase of real world problem scenario. Another group could then be formed consisting of individuals with

preference for evaluation during the solution selection and implementation phase. This can help in two ways. First, it can help capitalize on individual member skills and preferences for specific task phases and second, it would involve multiple employees in the problem solving process. This might lead to a greater acceptance of the selected solution, due to a feeling of greater involvement in the decision process for the employees within the organization.

Also this study helps inform managers of the differential influence of GSS when used to support the groups through both the phases. Managers can now be cognizant of different degrees of impact during the different phases when GSS is used to support groups during the creative problem solving process.

Limitations of the Study

As in most research studies, there were some limitations of this study. The first limitation was the use of student subjects for the purpose of this study. Although there are several arguments both for and against use of student samples, using student samples does restrict the generalization of the results. However, most students in this study were full-time working individuals and this could have helped partially mitigate the problems of using an inexperienced student only sample.

Another limitation of the study was the small sample size. The number of ideator groups was only 12 while the number of evaluator groups was 20 after accounting for the dropped groups. As discussed previously, the ratio of ideators to evaluators in previous studies were around 1:3. This was true in this research study as well. As a result,

recruiting more ideator group members was not viable within the constraints and time limit for the study.

The task used for the purpose of this study was selected on the basis of its relevance to the subjects that were participating in this study. Although this task was relevant to the students, they knew that they were not the final decision makers on this problem. Also accountability for the quality of the solution chosen was not enforced and hence this result cannot be generalized to individuals in the organizational setting, where groups are held accountable for their decisions and performance.

Also, this study used specific GSS software (Think-Tank) that was easily available for the purpose of study. Hence, it limits the generalization of the study results to GSS technologies with similar interface design and features.

The convergent idea selection phase was implemented such that the idea with the highest aggregated average of group member ratings was selected as the final solution. This may have impacted the results of the solution implementation phase, since only one idea was selected instead of a voting based mechanism. Thus this process of idea selection used in the study could have impacted the final results of the convergent phase.

Future Research Directions

The results from this study point to towards many potentially interesting and exciting avenues of research. Logically, the next step in this research would be to investigate the performance of heterogeneous groups (groups with members from each of the four quadrants on the creative problem solving profile) on the two phases of the creative problem solving process when assisted by GSS or similar kind of technology. This study

only considered the Knowledge Utilization dimension from the SIMPLEX model. Hence it might be interesting to see how the other dimension of Knowledge Apprehension plays into the entire creative process and it may be valuable to see the performance of teams with members from specific quadrants on the group creative process.

Another possible interesting study would be to see how nominal and face-to-face groups formed using the above preferences perform as compared to the GSS supported groups. It will be useful to see if GSS support shows significant impact on the multiple measures of performance used in this study as compared to the other two groups. For example, it might be useful to see how nominal, face-to-face groups and GSS supported groups perform on idea fluency, idea flexibility, idea originality and idea elaboration. This might give a much stronger evidence of how GSS impacts the group performance.

It may also be worthwhile to look into specific GSS design and features that may support evaluator groups better during the convergent phase. . Also it may be possible that different GSS designs or features may produce different impact on the performance of groups.

It might be interesting to see the performance of groups if top three or four ideas could be selected from the initial phase of idea generation. Then the groups could be given an opportunity to discuss and maybe vote among the top three or four ideas. For example, maybe an evaluation process which uses more voting features as well as discussion oriented environment may be more effective

Considering the experimental, lab setting of this study, it might be worthwhile to investigate how such GSS support impacts the performance of groups in the organizational setting, where the stakes for the decision maker are very realistic. From

the above ideas, it is seen that this study opens up a richer stream of research with multiple avenues for creativity, GSS and problem solving researchers.

Conclusion

This study looked at the performance of homogeneous groups formed using individuals with similar knowledge utilization preferences. Both the phases of the creative problem solving phase were studied. The ideator groups performed significantly better than their evaluator counterparts on the divergent phase of the creative problem solving process. However, no significant differences were found among the performance of the two groups on the convergent phase of the task. This may lead to the conclusion that the GSS used in the study was primarily influential in the divergent phase of the creative problem solving process.

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APPENDIX A-1

Creative Problem Solving Profile

Creative Problem Solving Profile

Creative Problem Solving Inventory

This inventory is designed to describe your method of problem solving. The aim of the inventory is to describe how you solve problems, not to evaluate your problem solving ability. You may find it hard to choose the words that best describe your problem solving style because there are no right or wrong answers. Different characteristics are equally good.

Instructions

Eighteen rows of four words are listed horizontally. Fill this questionnaire out **horizontally**, not vertically. That is, going **across each row**, assign a "**4**" to the word which **best characterizes** your problem solving style, a "**3**" to the word which next best characterizes your problem solving style, a "**2**" to the next most characteristic word, and a "**1**" to the word which is **least characteristic** of you as a problem solver. Be sure to **assign a different number** to each of the four words in **each horizontal row**. **Do not make ties in any row. Every row must have a 4, 3, 2 and 1.**

	Column 1	Column 2	Column 3	Column 4
1	Alert	Poised	Ready	Eager
2	Patient	Diligent	Forceful	Prepared
3	Doing	Childlike	Observing	Realistic
4	Experiencing	Diversifying	Waiting	Consolidating
5	Reserved	Serious	Fun-loving	Playful
6	Trial & Error	Alternative	Pondering	Evaluating
7	Action	Divergence	Abstract	Convergence
8	Direct	Possibilities	Conceptual	Practicalities
9	Involved	Changing Perspectives	Theoretical	Focusing
10	Quiet	Trustworthy	Responsible	Imaginative
11	Implementing	Visualizing	Describing	Zeroing In
12	Hands On	Future-Oriented	Reading	Detail-Oriented
13	Physical	Creating Options	Mental	Deciding

14 Impersonal	☐	Proud	☐	Hopeful	☐	Fearful	☐
15 Practicing	☐	Transforming	☐	Thinking	☐	Choosing	☐
16 Handling	☐	Speculating	☐	Contemplating	☐	Judging	☐
17 Sympathetic	☐	Pragmatic	☐	Emotional	☐	Procrastinating	☐
18 Contact	☐	Novelizing	☐	Reflection	☐	Making Sure	☐

View Your Profile

APPENDIX A-2

THE PROBLEM SOLVING TASK

You have been selected to help the university with a problem by providing a new and fresh perspective.

After years of problems, the University Coffee Shop has finally gone bankrupt and has been shutdown. The school administration now has an empty space and is trying to decide what kind of business should go into the space.

The university has chosen you as a group to help them by coming up with a solution to their problem. Here is what has been laid down for you:

1) First, you will brainstorm to come up with as many ideas of possible businesses as solutions to their problem.
2) After that you will as group evaluate all these ideas on the basis of cost effectiveness, feasibility and Originality and vote as a group to pick a solution your group thinks is the best and most novel solution.
3) After picking this solution, you will go ahead and outline in brief the different steps the administration should take to actually implement your solution.

APPENDIX A-3

POST GROUP ACTIVITY SURVEY

Section 1: Group Climate

Please read the following statement and rate your agreement/disagreement with the same.

The following is the scale used in the survey
1: Strongly Disagree
2: Disagree
3: Neither Agree nor Disagree
4: Agree
5: Strongly Agree

1	I felt at ease when trying to express my ideas	1 2 3 4 5
2	I could express my idea immediately after I thought of it.	1 2 3 4 5
3	I felt comfortable with my group enough to freely express my ideas	1 2 3 4 5
4	I had to wait for others to finish before I could express my ideas	1 2 3 4 5
5	I felt apprehensive about how the group would react to my idea	1 2 3 4 5
6	I expressed all ideas that occurred to me	1 2 3 4 5
7	I was afraid of criticism while sharing my ideas	1 2 3 4 5
8	I did not share all my ideas because I was listening to ideas shared by other group members	1 2 3 4 5
9	I was not worried about how my ideas would be received	1 2 3 4 5

Section 2: About Yourself

Please indicate which of the following adjectives best describe you.

Check all that apply.

_____ Capable	_____ Honest
_____ Artificial	_____ Intelligent
_____ Clever	_____ Well-mannered
_____ Cautious	_____ Wide interests
_____ Confident	_____ Inventive
_____ Egotistical	_____ Original
_____ Commonplace	_____ Narrow interests
_____ Humorous	_____ Reflective
_____ Conservative	_____ Sincere
_____ Individualistic	_____ Resourceful
_____ Conventional	_____ Self-confident
_____ Informal	_____ Sexy
_____ Dissatisfied	_____ Submissive
_____ Insightful	_____ Snobbish
_____ Suspicious	_____ Unconventional

Section 3: Biographical Information

1) Age:

2) Gender: _____ Female _____ Male

3) Work experience: _____ Years _____ Months

4) Position held at Work:

5) Highest Education Received:

6) Previous Experience in Idea Generation (Example would be previous brainstorming experiences/ participation in an idea generation study)? No Yes (_____ times)

Lowest Highest

7) Experience in using a computer on a scale of 1 to 5: 1 2 3 4 5

8) Typing speed: _____- words per minute

9) What did you think about the use of group process followed for making decisions?

Positives:

_____
_____
_____
_____

Negatives:

_____
_____
_____
_____

10) What did you think about using software for interacting as a group?

Positives:

_____
_____
_____
_____

Negatives:

_____
_____
_____
_____

Thank you very much for filling out this survey! Your help is appreciated.

APPENDIX A-4

EXPERIMENTAL SET UP AND SCRIPT

Before experiment starts use lab map to seat students as they come into the lab to take part in the experiment. Make sure all the users are logged in. All groups should consist of 4 members. Time overview: (total of 1 hour available, plan for 1 hour 15 minutes for "cushion")

Time	Total minutes strictly enforced?	Task	Notes
0:00-0:05	**No** – but don't say anything that's not on script	Session start read introduction script /rules Introduce the activity and explain the steps in brief	As students come in, make sure they DO NOT use the computers in ANY way (especially surfing or loading software), and help them find their assigned workstation. Make sure everybody is at the start page (bulb screen)
0:05-0:15	**Yes** – but don't say anything that's not on script	Training on entering data into Think-Tank where and how	This will take a little longer than the control groups – make sure everyone knows how to use Think-Tank before starting!
0:15-0:30	**Exactly 15 minutes** Strict time enforcement down to the second! STOP participants in folders in the same order they were started in	Idea Generation	20 minutes to do this task!
0:30-0:35	Exactly 5 mins	Idea Elaboration	
0:35-0:40	Move Participants to Elaboration phase		
0:40-0:50	**Exactly 10 minutes** Strict time enforcement down to the second!	Select Ideas Voting	Regardless of when you start, only give them 10 minutes for this portion!
0:50-1:00	**Exactly 10 minutes** Strict time enforcement down to the second!	Solution Elaboration	
1:00-1:10	No	Post session	Hand over the post session survey. Thank them for their time.

The actual script has been outlined below:

Introduction

"Hello, my name is Deepa. Welcome to the Group Activity session as a part of helping with my dissertation. I will be reading a script to ensure that everyone in every lab receives the same instructions and has the same experience. This is done to ensure fairness across groups and to help with the reliability of the data we are collecting. Thus, please listen carefully as I can only answer certain questions at a certain time.

I will start by reading the rules for this lab, which are the following:

1. No talking verbally with your group unless or until you are told to do so.
2. You must explicitly follow the given instructions from the facilitator.
3. If you "surf", load software without being directed to do so, or work on non-lab related activities you will be excused immediately and will not receive credit for participating in the assignment.

We will be using the brainstorming technique to try and solve a business problem at hand. There are some brainstorming rules that should be followed that I am passing out right now. The rules state that while in the brainstorming phase, there should be no criticism. Remember, the wilder the ideas, the better it is and It is always easier to tame down than to think up. Try to think of as many ideas as possible, the more the merrier.

Does everyone understand? (Wait for affirmation from the groups.)

Before we get started on the actual task, we shall try to familiarize ourselves with the software that we are going to use. When instructors talk about global teams that consist of people from different parts of the world, such kind of software helps them to interact and communicate in order to make decisions on business matters.

Training on Think-Tank

At this point all of you should go ahead and log in using the yellow post-it note which contains information about username, session id and passkey for this activity. After doing this all of you should see a bulb image. Does everyone see it? (Wait for affirmation from all users)

I will be your facilitator for both the practice session as well as the actual task. That means I will help you move from one phase to another, without actually participating in the group activity.

I am now going to start moving each group into the first phase of the practice task, the idea generation phase. [Move all users to the first phase of the task] All of you should now see a "Chat-like" screen, where there is place at the bottom to type in your ideas and a send button to actually send it and share it with the rest of the group. Go Ahead and just for fun, type in three ideas that you can think a "Rock" also known as "Stone" can be used for.

You should start seeing ideas appear on the screen. Some ideas appear bold, meaning you haven't read those. There are numbers next to the ideas. Those represent comments on that idea. Remember, comments are meant to help build the idea or clarify it. NOT to pass judgment. Go ahead, pick an idea and comment on it. Now, I will move you all to the next phase.

Here, all the ideas generated by you will be evaluated by you. [Move] The scale is from 1 to 5, where 1 stands for lowest and 5 stands for highest. Rate each idea and click on the button on the left corner of the screen that says ("Cast Vote") Once you have cast

your vote, you will see the results screen. [Wait for 10 minutes] Can all of you please finish casting your votes? Thank you.

On the result screen, it will show you bar graphs. Up on the left hand side it says "Charts" and right next to it "Table". Please Click on the "Table" tab. Now you can see numbers associated with each idea. These numbers give you the average rating for the idea on the criteria. Click on the "Total" under the chart, table button. This total table gives you the aggregated rating for all idea on all the criteria that you have used as a group. The topmost idea with the highest average will be selected as the group's idea. I will now move you to the last phase of this practice phase.

Here, you will see a comments window to the right most side. Here you are to type in implementation steps that need to be taken, in order that your group's idea can be implemented. You are not to comment on the idea. You are to type in STEPS for implementing that idea ONLY! Does anyone have questions about the software since I will not be able to answer any questions once the real task has started? [Wait for answer]

We will now start the real task.

For the purpose of this activity, you are to assume that you are a part of an executive team that has been put together to help a university out on one of its problem areas. To solve this problem you will go through a brainstorming process first to generate as many ideas as possible that could be possible solutions to the problem listed at hand. Then, as a team you will weigh all the ideas generated and judge them on the basis of specific criteria individually. All ratings will be combined and one best recommendation will be picked for the University Committee to implement. Finally, you will try to be as specific as possible about the steps to be taken for implementing the idea you have recommended.

Please take this activity seriously as this will give you an idea of a real world decision making process in today's global environment. The task has been written on a piece of paper and will now be distributed.

Before I show you how to get started, does anyone have any questions – this is your last chance for questions? (Only answer general questions on grading, point of assignment – do not give details on strategies for completion, what other groups are doing, etc.)

I will now start each group on the first phase of generating ideas for the problem at hand. Please be patient since this will take around 5 minutes and your screens might look different from the person sitting next to you, since they may not be on the same group.

[Move them all to the first phase]

You will have 15 minutes to generate as many ideas as possible. [After 15 mins]

Now I want you to stop generating ideas and try to look at other ideas shared by your group members and try to build on those by making comments on the ideas. [5 mins]

STOP. AT THIS POINT I WILL MOVE ALL YOUR TEAMS TO THE NEXT PHASE, where you will evaluate the ideas generated. You will have 10 minutes to do this. [MOVE]

STOP you will now be moved on to the next phase, where the group has to come up with an implementation plan. You will have 10 minutes to come up with concrete steps that the university should take to implement the idea that had the highest total rating for the group. [MOVE] PLEASE STOP TYPING OR INTERACTING WITH THE SOFTWARE. The time allotted has been completed. Thank you for your time.

POST SESSION SURVEY

As a final part of the assignment, I am handing out this survey for you to complete before you leave. Please complete this as accurately as possible. Please complete the survey making sure to answer each question completely. Please put your yellow post-it note on the survey, so that I can give your names for you to get credit, to your instructor.

Finally, as a last reminder: during the remainder of the week DO NOT discuss this lab activity with anyone inside or outside of the class. This includes telling them what you did and what software you used. Don't even discuss this with your group members, as people can easily overhear what you're talking about. After two weeks, you are free to discuss it. Thanks for your time. I really appreciate it. You are free to go.

APPENDIX A-5
IRB APPROVAL

Oklahoma State University Institutional Review Board

Date:	Monday, November 27, 2006
IRB Application No	BU0650
Proposal Title:	Impact of Group Member Creative Style on Creative Problem Solving Process in a Technology Mediated Environment
Reviewed and Processed as:	Expedited

Status Recommended by Reviewer(s): Approved Protocol Expires: 11/26/2007

Principal Investigator(s

Deepa Ray
OSU Tulsa 372 N. Hall
Tulsa, OK 74106

Nicholas Romano
344 North Hall
Tulsa, OK 741060700

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☑ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C. Jacobs, Chair
Institutional Review Board

VITA

Deepa Kajal Ray

Candidate for the Degree of

Doctor of Philosophy

Thesis: IMPACT OF GROUP MEMBER CREATIVE STYLE ON CREATIVE PROBLEM SOLVING PROCESS IN A TECHNOLOGY MEDIATED ENVIRONMENT

Major Field: Business Administration

Biographical:

Education: Received Bachelor of Engineering degree in Electronics Engineering from the University of Mumbai, Mumbai, India in 2000; Received Master of Science degree in Telecommunications Management from Oklahoma State University, Oklahoma in 2003; Completed the requirements for the Doctor of Philosophy degree with a major in Management Information Systems at Oklahoma State University in July, 2007.

Experience: Worked as a Software Programmer for Horizon-ITL, India from July 2000-February 2001; Employed as a graduate assistant for the MSTM program at Oklahoma State University, Stillwater, OK from August 2001-May 2002; Employed as a Graduate Teaching Associate, Oklahoma State University, Stillwater, OK from 2002-2006; Employed as an Visiting Professor of Management Information Systems at Oklahoma State University, Tulsa, OK, 2006-2007.

Professional Memberships: Association for Information Systems, Decision Sciences Institute.

Name: Deepa Kajal Ray Date of Degree: July, 2007

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: IMPACT OF GROUP MEMBER CREATIVE STYLE ON CREATIVE PROBLEM SOLVING PROCESS IN A TECHNOLOGY MEDIATED ENVIRONMENT

Pages in Study: 86 Candidate for the Degree of Doctor of Philosophy

Major Field: Business Administration

Scope: This study investigated how homogeneous teams with members with a specific cognitive style perform on the two phases of a creative problem solving process when facilitated by GSS. Ideators groups were compared to Evaluator groups in terms of their performance on the divergent and convergent phases of the creative problem solving process.

Method of Study: This was a single factor quasi-experimental study which compared performance of Ideator groups to Evaluator groups on the idea generation and idea evaluation phase of the creative problem solving process using MANOVA. The dependant variables were idea fluency, flexibility, originality and elaboration for the divergent phase and solution fluency, solution elaboration and solution novelty for the convergent phase. There were total number of 31 groups in the sample

Findings and Conclusions: Significant differences were found between the performance of ideator and evaluator groups on the divergent phase. However no significant differences were found between the two groups on the idea selection phase, leading to the conclusion that the GSS used in the study was primarily influential in the divergent phase.

ADVISER'S APPROVAL Dr Nicholas C. Romano, Jr.