Do Visualizations Foster Experience Sharing and Retention in Groups? Towards an Experimental Validation

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Abstract: In recent years the visualization of knowledge has been gaining wider attention: visualization is said to enhance human capabilities for knowledge intense activities such as decision making and strategic thinking. However, this is a recent field and still widely unexplored. Thus far, the advantages of knowledge visualization have been investigated mainly through anecdotal evidence and qualitative studies. In this paper, we propose an experimental approach to further comprehend the role of visualization in fostering knowledge sharing. We plan to compare the elicitation and evaluation processes of groups who are provided (1) with an optimal visual support, (2) with a sub-optimal visual support, and (3) without any visualization. The goal of our research is to apply the experimental approach – widely used in studying GSS (Group Support System) but seldom used in knowledge management – to shed light on the role of visualization for knowledge-intensive tasks in groups. We report first preliminary results of an experiment with 56 MBA students and also outline the limitations of our approach.

Keywords: knowledge visualization, collaborative visualization, Group Support Systems, knowledge work, knowledge sharing.
Categories: H.4.3, H.5.3, J.5, M.0

1 Introduction

Collaborative knowledge work, such as experience sharing and decision making in meetings, is a crucial task in organizations: the quality of the decision process and outcome can have a dramatic impact on a company‘s performance. Several scholars have investigated how information visualization can help in strategic thinking, by lowering the cognitive load, providing fast insights and allowing for comparisons [Shneiderman, 96][Blackwell, 01]. Similarly, the visualization of knowledge can potentially augment the quality of knowledge-intensive tasks such as decision making, sharing knowledge, creating ideas, evaluating and planning [Bitter-Rijpkema, 02] [Coffey, 04]. Thus far, this interdisciplinary field is still in an emergent phase [Lai, 08].

With our current research, we aim at understanding how knowledge tasks in teams can be improved by using visual support. We focus on computer-based visualizations, as for example visual metaphors, diagrams, mind maps, matrices, timelines, templates, etc. (see examples in Figure 1). First, we investigate which

characteristics of knowledge visualization can facilitate knowledge work in groups. Second, we plan to compare knowledge sharing and evaluation of groups that have a visual support and groups that have no support other than a flipchart. With our investigation we attempt to provide evidence for the efficacy of visualization for facilitating knowledge intensive tasks such as experience elicitation and sharing. To reach this goal we propose to conduct an experiment with managers, giving them a typical organizational task of sharing strategic experiences and ranking (evaluating) these experiences by importance. We will then compare the results of the groups with a fitting visual support, with a sub-optimal visual support, and with no visual support.

In GSS (Group Support Systems) and DSS (Decision Support Systems) there is a long tradition of experimentation, comparing for example, face to face meetings with distributed meetings, or comparing different kinds of supports [Carey, 97] [Fjermestad, 98] [Briggs, 06] [Reinig, 07]. Conversely, in knowledge management experiments are not an often used method, with few exceptions [Brodbeck, 02]. We aim to bridge the findings and traditions of both fields, by proposing a compound methodology, based firstly on qualitative studies (interviews and observations) that lead to the development of the *collaborative dimensions framework* [Bresciani, 07], and then to an experimental approach.

2 Research question and design: investigating collaborative knowledge visualization

The main research question of this study is to investigate if visualization improves experience elicitation, sharing and evaluation in groups. We consider it a relevant question at a theoretical level, to investigate if and how visualization can function as a support for cognitive tasks and for integrating knowledge collaboratively in a group with a common goal. At a practical level, we aim to provide guidelines for choosing or modifying visualizations in order to select the best support for knowledge intensive tasks in group.

To answer this complex and interdisciplinary research question we propose a three step design, which is an integrated combination of different scientific methods [Hollan, 00].

In the *first step* we have started by looking into the literature of diverse related fields (information visualization, diagram studies, knowledge management, management). We have also used qualitative methods to gain insight from the field to integrate the findings from the literature: we have conducted seven semi-structured interviews with practitioners (strategy consultants) and we have observed several meetings in organizations. Through the process explained in [Bresciani, 08] we have proposed a *collaborative dimensions framework*, composed of seven main dimensions mediating the efficacy of visualization in collaborative knowledge work. These dimensions are: visual impact, clarity, perceived finishedness, directed focus, inference support, modifiability and discourse management.

The *second step* consists of matching the most used visualizations in organizations, with typical group activities. We have selected twelve visualizations

that are widely and commonly used for facilitating strategic meeting in organizational settings. For each visualization, we have asked survey participants to rate the usefulness of the visualization (on a 5 point scale) for the following four tasks: idea generation, knowledge sharing, options evaluation and activity planning [Eppler, 05]. At present, we have collected the results of 64 people participating in the survey, all of whom are middle managers, taking part in executives programs in Switzerland. The result of the matching provided us a perception of managers' on visualization methods from the most to the least suitable for each of the four tasks.

The *third step* is the actual experiment. We plan to conduct an experiment using managers (of executive MBA classes) as subjects and asking them to complete two tasks, in groups of five people. Of the previously mentioned typical tasks we choose one divergent and one convergent task, specifically knowledge sharing (divergent) and evaluation (convergent). We create three conditions with different degrees of suitable visualization support. The optimal and suboptimal visualizations are chosen according to the results of the survey conducted in the second step and adapted (to leverage specific dimensions) accordingly to the collaborative dimensions framework, explained in step one. This results in a 3x2 experimental design. To allow for significant results, we will have at least five groups per condition. More details about the design of the experiment are discussed in chapter 3.

At present we have conducted step one and two, generating a framework with seven dimensions [Bresciani, 08] and we have analyzed the results of the matching test. However, we conceive the research design as an iterative process, where new findings in the second and third step, take us back to the beginning and suggest new or different aspects to be considered. We also plan to conduct further matching tests (step two) in the next few months to consolidate the results.

3 Experimental Design

In the previous chapter we have briefly explained the third research step, consisting of a 3x2 experimental design, with two tasks: (1) knowledge sharing, (2) evaluation, and three conditions: (I) optimal visualization, (II) suboptimal visualization and (III) no visualization support. The independent variable is the visualization support fit for the task (based on previous findings), and the four dependent variables are: satisfaction (with process and outcome) [Briggs, 06], participation equality [Zmud, 02], productivity [Reinig, 07] and retention (memorability).

3.1 Hypotheses

The main goal of our research is to investigate if the use of an appropriate visualization for a group task improves knowledge work. We decompose this broad goal into measurable and testable hypotheses, based on the aforementioned dependent and independent variables:

H1 Using an appropriate visual support for a task has a positive impact on *satisfaction* compared to using no visual support

H2 Using an appropriate visual support for a task has a positive impact on *participation equality* compared to using no visual support

H3 Using an appropriate visual support for the task has a positive impact on *productivity* compared to using no visual support

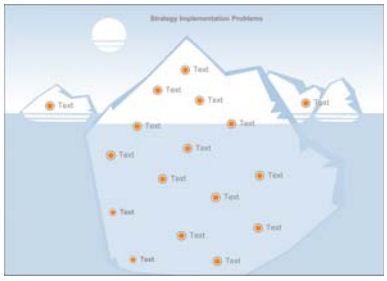
H4 Using an appropriate visual support for a task has a positive impact on *retention* compared to using no visual support

With regard to the sub-optimal visualization, we tentatively hypothesize that its effectiveness will be above the un-supported condition.

3.2 Task

We conduct the experiment asking groups of five managers firstly to discuss and share their experiences on the problems and pitfalls of *strategy implementation*, and secondly to rank the problems they will have identified in three groups in order of relevance (low relevance, medium relevance and high relevance).

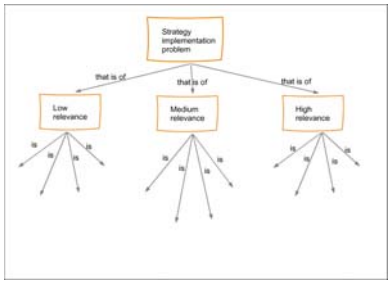
In the first condition, the groups will be provided with one of the best fitting visualizations for the two tasks that have emerged from the matching test: that is the iceberg visual metaphor (Figure 1a) for knowledge sharing, and the matrix for the evaluation task (Figure 1b). In the second condition the groups will have to use a badly fitting visualization support for the task, which is the timeline (Figure 1c) for knowledge sharing and the concept map (Figure 1d) for evaluation. In the third condition, the groups will not be provided with any visualization, but simply with a flipchart.



a. Iceberg Visual Metaphor

b. Matrix (2X2)

c. Timeline



d. Concept Map

Figure 1: Graphic templates used in the experimental tasks

We will create random groups of five managers from executive MBA classes from Switzerland. The choice of MBA students in this case is particularly suitable because they are managers with at least 5-10 years experience, which is closely the target of typical users we are addressing in our study. They also should have prior knowledge in strategy and in the process of group decision making. We will have control questions to enquire their experience. The groups will be randomly assigned by the experimenters as suitable in most experimental settings [Campbell, 73][Friedman, 94]. We will have at least five groups for each condition. One member of each group will act as a facilitator who will use the computer and manage the visual facilitation software [Fjermestad, 98] or write on the flipchart.

3.3 Measurement

The dependent variables will be measured with both objective and subjective measures. In detail:

1. *Satisfaction*: with process and with outcome. Subjective measures through questionnaire validated scales [Briggs, 06].
2. *Participation equality:* Subjective measures through questionnaire validated scales [Zmud, 02] and objective measures of time talking, derived from the transcripts.
3. *Productivity*: effectiveness: number of admissible non redundant items; number of good ideas [Reinig, 07], (measured comparing literature of strategy implementation problems [Yang, 08]); efficiency: number of deviation from the topic and social talks (focus) derived from the transcripts.
4. *Retention*: quantity of items recalled, completeness and accuracy of ranking, quantity of items mentioned by other people [Brodbeck, 02].

Retention will be measured forty-five minutes after the experiment (after a diversion task of exercises/puzzles), by asking the participants to write down as many strategy implementation problems discussed, as they can remember, and then to rank them as in the group discussion.

We also plan a *debriefing session* after the experiment, where the subjects express their impressions about how they have managed the tasks. In particular they will be asked about the advantages and disadvantages of the support they have used, and relate it with their past experiences. The scope is to collect qualitative data that may shed light on not yet considered topics.

In brief, the experiment will be conducted with the following *procedure*. Before the actual experiment, each person is ask to write *individually* all the strategy implementation problems that they have experienced directly or indirectly. Then the experimenters assign the groups randomly; the participants form the groups and elect a facilitator (the participants are familiar with each other); the selected leaders of the two computer-based conditions are briefly instructed on how to use the software and its main features. They will have ten minutes to familiarize with the software and templates.

All the groups are given the same instructions (one page) to discuss problems of strategy implementation. In the first task they have to share their knowledge and experience and identify strategy pitfalls with the support of the tool provided. Then

they are asked to complete the fist part of the questionnaire. In the second task they have to rank the identified problems (low, medium, high relevance), with the second visualization provided. Then they fill in the second part of the questionnaires. The groups are randomly assigned to the three conditions. Each group discussion is recorded with an audio recorder (if the participants permit). The participants are allowed 60 minutes to complete the two tasks and the questionnaires. After the process and a diversion task, the recall exercise is administered. Finally a plenary debriefing session with all the participants is conducted.

The *analysis* of the results will be conducted by two independent coders who will judge the resulting ideas and the transcripts of the recorded dialogues.

As all experiments, the one presented here has *strengths and limitations*: the biggest strength we believe is that the subjects are real managers with several years of experience and they are familiar to each other. The tradeoffs of this choice is that we have constraints in the choice of the procedure because we have to strike a balance between the experimental requirements (such as recording the conversation) and the didactic context of an MBA (such as motivating the participants with educational content, or limiting the questionnaire to a small set of questions). Other *limitations* introduced by the experimental setting include personal differences: different familiarity with strategy implementation and with group support systems may introduce biases in the analysis. For this reason we introduce control questions in the questionnaire measuring familiarity with strategy and with visualization facilitated meetings. Personal preferences for the use of visualization might also have an impact. A further limit is that the subjects of the experiment are managers with very high education level (MBA) and the generalization of the experiment might be limited to experienced managers in Western companies.

3.4 Preliminary results

To date, we have conducted a first experiment with 56 managers attending an executive MBA program at the University of Geneva. The data is not yet sufficient to draw statistically significant conclusions and we have plans to replicate the experiment in the near future. However, the data collected thus far is very encouraging: the rough count of the number of strategy implementation problems identified by the groups (part of the effectiveness measure), resulted in an average of 16 items for the computer-supported groups and an average of only 12.5 items for the unsupported groups. We also analyzed the recall tests and we obtained an average of 12.5 items recalled for the visualization supported groups and an average of 8 items for the non supported condition.

We recognize that these are incomplete and inaccurate scientific measures, but we see them as a first confirmation of the feasibility of our experimental design. The preliminary results also show that our effort in measuring the effects of visualization on group meeting support is a promising field of research.

4 Conclusions

Our current work focuses on investigating the effect of organizational meetings mediated by computer supported visualization. We have presented the current state of

our ongoing research and proposed an experimental design to gain solid insights on the role of visualization for group knowledge sharing and evaluation. We believe that examining this topic is highly relevant, both at a theoretical and a practical level. Our research hypothesis is that an appropriate visualization support leads to better performance than a non supported or sub-optimal support. We have explained in detail the preceding phases of our research and how we plan to conduct the experiment to test our hypotheses. We have also reported some very preliminary but encouraging results.

This type of research design can easily lead to further investigation of several variants, such as cross-cultural issues [Reinig, 08], comparing mixed groups, comparing different supported visualizations (paper, software, whiteboard), varying group size or task complexity. The experiment has already been planned in a way to allow for cross-cultural comparisons, which we plan to conduct by comparing results of Swiss and Chinese participants. The experiment results could also be integrated with results from the field, such as through context rich field experiments or action research. Alternatively, each of the dimensions of the framework can be investigated in more detail, with a dedicated experiment.

The results of this research are expected to provide solid understanding of the effect of using visualization for knowledge-intensive tasks in organizations. If our hypothesis will be confirmed, the implications will be significant for practitioners in companies, as well as for scholars in several fields, including information visualization, knowledge management and group support systems.

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