Combinatorial Inquiries into Knowledge Federation

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Abstract. Combinatorial inquiry is an emerging method for developing shared understanding of complex systems. The method leverages mathematical principles to propose participatory research strategies for systems of topics. Using the people-process-content-technology system as the basis for the combinatorial inquiry, this leads to proposing three inquiries, collaborating with the organization development, usability, and knowledge management communities, respectively. Future directions include constructing combinatorial inquiry as a theory, federating the conference papers with respect to journalism, and a proposal for inquiring into collective action as the paper for October 2012.

Keywords: Bootstrapping, Collective Action, Combinatorial Construction, Combinatorial Inquiry, Combinatorial Reduction, Co-Operative Inquiry, Journalism, Knowledge Creation, Knowledge Federation, Knowledge Management, Knowledge Sharing, Organization Development, Theory Construction, Usability, User Interfaces

1 Introduction

This paper clearly illustrates that the inquiry process is highly self-organizing, as this paper now proposes much different systems of inquiry than the initial version presented at the Second International Workshop on Knowledge Federation held in October 2010. As the exploration has continued, a new approach has emerged in just the past few days, resulting in the combinatorial inquiry method and subsequent proposals having a clearer connection with knowledge federation!

The exploration offers six proposals for topics of inquiry, introducing an inquiry method that leverages mathematical principles for building shared understanding of complex systems through participatory research. This inquiry method is distinguished by a foundation applying a combinatorial reduction/construction process for modeling systems. For this process, the proposal topic is defined as a system, considered as a fully-connected network of components (research subtopics). Combinatorial reduction focuses on research into the direct 1:1 relationship between each pair of subtopics, referred to component-pairs for the combinatorial inquiry description, and topics in knowledge federation proposals. Combinatorial construction then rebuilds the system model by integrating research findings into

component-pairs, with the learning objective to gain a systemic understanding of the combinatorial inquiry topic.

The method is also grounded in participatory research methods, for which John Heron provides a comprehensive framework from which to evaluate such methods.[3] Participatory research can be conducted through one of three modes, identified by John Heron as hierarchy, co-operation, or autonomy. The three modes can provide the basis for an entire combinatorial inquiry, or each component-pair inquiry, or even each stage or meeting within an inquiry [4].

The six proposals are summarized in Table 1, with proposed topics for the three involving the knowledge federation community. The complementary three inquiries among the other three communities would be co-determined by them. The first proposed inquiry is research on knowledge creation and sharing, engaging the organization development community. The organization development discipline provides grounding in both knowledge creation and facilitation methods representing the People-Process component-pair. The knowledge federation discipline provides leadership in preserving meeting archives and context, representing the Content-Technology component-pair. The second proposed inquiry is collaborative research with the usability community, on the user interfaces to federated knowledge repositories. For this inquiry, the usability community represents the People-Content component-pair, while knowledge federation represents the Process-Technology component-pair. The third proposed inquiry is outreach to the knowledge management community, with the topic being federating knowledge among communities of practice. The knowledge management community represents Process-Content, while the knowledge federation community represents People-Technology.

Table 1: Combinatorial Inquiries

Component-Pairs	Communities	Combinatorial Inquiries
People-Process	Organization Development	•Knowledge Creation and Sharing
Content-Technology	Knowledge Federation	•Facilitating and Archiving meetings
People-Content	Usability	•User Interfaces to Federated Knowledge Repositories
Process-Technology	Knowledge Federation	

Process-Content	Knowledge Management	•Federating Knowledge among communities of practice
People-Technology	Knowledge Federation	

2.   Combinatorial Inquiry: A Systems Model for Social Inquiring

The mathematical foundations for combinatorial inquiry are four methods that enable a structured approach for developing a greater understanding of complex systems. These methods are combinatorial reduction and combinatorial construction, qualitative combinatorial analysis, and qualitative combinatorial modeling.

The methodological foundations for combinatorial inquiry research at the component-pair level are the principles of co-operative inquiry, as developed by John Heron and Peter Reason.   The core principle of co-operative inquiry is that research is conducted 'with people' rather than 'on people'.   While these co-operative principles as conceived apply to people conducting research, they also provide profound insights for establishing and maintaining integrity of relationships among knowledge domains.

2.1   Combinatorial Reduction/Construction

When modeling a system as a fully connected N-node network, the traditional reductionist approach focuses on each node separately as the base unit of consideration. While any system must initially be defined by conceptions of these individual nodes, the combinatorial approach presented here complements this traditional reduction process at two levels.   First, the distinction made here is that combinatorial reduction makes the base unit for study a pair of nodes and the line connecting them, representing the 1:1 relationship between them, with this base unit referred to as a component-pair. Combinatorial construction then develops a systems perspective of an N-node system by federating or integrating component-pairs.

As shown in Table 1, for the 4-topic system of People-Process-Content-Technology, there are 6 component-pairs.   These pairs are then mapped to the four communities proposed for the inquiry, resulting in three subtopics for the knowledge federation community to engage in three separate inquiries with each other community, described in Section 3 below:

  1. Knowledge Creating and Sharing (Organization Development)

2. User Interfaces to Federated Knowledge Repositories (Usability)
3. Federating Knowledge Among Communities of Practice (Knowledge Management)

2.2 Co-Operative Inquiry

In essence, combinatorial inquiry provides the means for organizing and integrating co-operative inquiries. Co-operative inquiry is conducted in a cycle alternating between reflection and action: each person is co-subject in the action phases and co-researcher in the reflective phases. The initial reflection phase is comprised of the entire group as it forms and collectively defines the nodes of the complex system that is their subject of inquiry. In the first action phase, subgroups focus on a component-pair, to further co-develop their initial understanding and co-determine their course of action, through direct dialogue. This informs the second action phase, in which each subgroup fully engages in the inquiry at individual and/or collaborative levels. At an appropriate interval specified by the group in phase 1, the whole group gathers to share their experiences, their courses of action, and reconsider the inquiry. Subsequent cycles are structured by combinatorial reconstruction, enabling remaining component-pairs to be the subject of an inquiry during each cycle, until each component-pair has been a subject of inquiry, once and only once. This construct is shown in the table below for a system of six components, where rows represent subsystems. For fully implementing the co-operative inquiry method, a system of six components is the minimal level of inquiry, as there need to be five to eight cycles.

In guiding these cycles, co-operative inquiry serves as a comprehensive multi-dimensional framework that provides context for understanding and conducting participatory research, and has profound implications for knowledge federation and journalism. Of the many dimensions, one most pertinent to combinatorial inquiry is a distinction Heron makes between Apollonian or Dionysian inquiries. The application of combinatorial principles to co-operative inquiry can be seen from one perspective as a pure Apollonian inquiry, although another perspective is that combinatorial reconstruction could provide an infrastructure (the framework of the cathedral), while each inquiry of a component-pair could be Dionysian in nature (a bazaar within the cathedral). As defined by Heron: "The Apollonian inquiry takes a more rational, linear, systematic, controlling and explicit approach to the process between reflection and action."[7] In contrast, "The Dionysian inquiry takes a more imaginal, expressive, spiraling, diffuse, impromptu and tacit approach to the interplay between making sense and action."[7]

3 Proposals for Combinatorial Inquiries

As outlined in the introduction, combinatorial reduction of the people-process-technology-content system provides a framework for engaging the organization development, usability, and knowledge management communities. The intent is for these six inquiries to be conducted concurrently, with three separate teams from each community. Once these six inquiries are completed, they can themselves be federated in several ways. Each of the four communities could federate their three inquiries. A second way to federate would pair the complementary inquiries with each of the corresponding knowledge federation inquiries, so a shared understanding could be developed for the component-pairs of 1) People-Process with Content-Technology; 2) People-Content with Process-Technology; and 3) People-Technology with Process-Content.

3.1 Knowledge Creation and Sharing

This proposed inquiry with the Organization Development community would explore how our two communities can enable more effective meetings, through facilitation methods and managing artifacts. For the purposes of this inquiry, the following relationships among knowledge, learning, and conversations provide a context for how knowledge is generated. Learning is the process by which an individual makes sense of the knowledge gleaned and assimilated from prior experience, developing an understanding of a subject area (topic). Individuals bring their understanding as background knowledge to be shared during the course of conversations, which provide the context for generating new knowledge. This leads to considering knowledge as the outcome of social inquiring.

Among contributions from the organization development field, the inquiry would employ the three modes of facilitation identified by John Heron – hierarchy, co-operation, and autonomy -- would be used at different points in the process [8] Hierarchy is often used at the beginning of an inquiry, where a facilitator takes charge of the process and identifies learning objectives, exemplified by the traditional roles of teachers designing lesson plans. Co-operation is frequently used during the middle stages, where the facilitator is more in the role of a coach, guiding the process while sharing power. In later stages, the autonomy mode becomes more applicable, where the group learns in a open, self-organizing fashion. This mode is exemplified by the dialogue process, based on David Bohm [3], William Isaacs [8], and Yankelovich[17]. Additional references for knowledge creation, experiential learning, and catalytic conversations from the organization development field include von Krogh, Ichijo, and Nonaka [14] and Baker, Jensen, and Kolb [2] and Baker [1], respectively.

The knowledge federation community can augment these practices by providing the technical environment for capturing meeting content through the process of

dialogue mapping process developed by Jeff Conklin [5] and Compendium software, capturing the conversation in an Issue-Based Information System (IBIS) format. The ability for transclusion in compendium provides a mechanism for federating meetings, providing an ongoing account of a project. For the hierarchy mode of facilitation, a facilitator can populate a dialogue map with questions, a process referred to as Issue Mapping. The Dialogue Mapping method resonates well with the co-operative mode, enabling real-time capture of the conversation, and could be used in the autonomy mode in some instances.

3.2 User Interfaces to Federated Knowledge Repositories

This would be a proposed inquiry with the usability community, with a focus on how our two communities can provide leadership in full access and participation to collaboration. Two core activities would be first, ensuring full participation for people with disabilities, both in collaborating with any other person and accessing content., for people with disabilities, and second, interfaces for mobile devices. A major reference point for this inquiry is the work of Malchanau [11] and Malchanau, van der Vet, and Roosendaal [10] on Habitable Interfaces. This work is extremely pertinent, as their focus is on interface design for accessing federated scientific information. Even through the brief descriptions of these inquiries, there are substantial connections between them. How does IBIS and Habitable Interfaces complement each other? What are the connections between Habitable Interfaces and the Digital Habitats efforts described in the next section?

3.3 Federating Knowledge Among Communities of Practice

This would be a proposed inquiry with the Knowledge Management community, with a focus on how our two disciplines can enable deeper connections among communities, with the challenge of honoring the differences among communities of practice. A key resource for this inquiry is the work of Wenger, White, and Smith on Digital Habitats: Stewarding Technology for Communities [16]. They ask three questions that are central for this inquiry:
- What aspects of technology should a steward consider?
- Why are various tools useful for communities?
- What are patterns of community activities that technology can support?

4 Future Directions

There are several activities that are natural progressions of this work, with the first being a proposal for strengthening the theoretical foundation of combinatorial inquiry.

The second will employing the combinatorial inquiry method for federating our papers, focusing on the journalism theme. This would provide the reference perspective for a more detailed inquiry into collective action.

4.1 Bootstrapping Combinatorial Inquiries

This project would be refining the combinatorial inquiry process, serving as the project planning activity for conducting inquiries. A key aspect of this would be applying combinatorial techniques for an integrated process to facilitate meetings. One of the subtopics for this inquiry would be theory construction, to determine the validity of the combinatorial inquiry process to be considered a theory. Three sources for making this determination are Ben-Ari [3], Reynolds [12], and Rosenau and Durfee [13]   Included in this inquiry would be the effort to integrate the results of the three inquiries outlined in Section 3.

4.2 Federating the KF2011 papers

This project would be a collaborative effort of the Knowledge Federation community, with an initial proposal to federate around our theme of journalism. This would be done in the autonomy mode in a self-organizing manner, so any further comments are beyond the scope of this paper.

4.3 Combinatorial Inquiries into Collective Action

Research for this paper has generated some ideas about how journalism can be a component within a Collective Action System. Most appropriately, the timing for sharing these papers provides the opportunity for an amazing year of activity leading up to the 50th anniversary of Augmenting Human Intellect: A Conceptual Framework [6], coinciding with our Workshop VI: Systemic Innovation for Collective Creativity! How can we be federating the contributions of this and many other communities toward a more comprehensive effort for raising collective intelligence, for enhancing our capabilities for dealing with the increasing complexity of our challenges?

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