Requirements Elicitation – What's Missing?

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Abstract

In this paper we show that interviews between IT consultants and clients are considered best practice in terms of methods for eliciting IS requirements as part of IS development projects. The process of conducting successful conversations with clients as part of requirements elicitation interviews is not well understood. The paper reports a literature survey which established current understanding. To date this understanding has been achieved through research which: considered conversations as black boxes; proposed and implemented treatments to be applied by consultants; and then measured the quality and quantity of the requirements elicited. The treatments have not been successful as poor requirements elicitation continues to be a major problem in IS development. Our analysis of current understanding indicated that consultants' experiences of the nature of conversations with clients and approach to conducting conversations have not been studied. It would seem imperative to look inside the black box of consultants' experiences of conducting conversations with clients if improvements to the outcomes of requirements elicitation are to be made. A study is proposed which aims to examine variation in how consultants experience requirements elicitation conversations. Through analyzing the variation in the light of current best practice it is aimed to identify the critical aspects of successfully conceived and conducted conversations. These critical aspects can then be used in IS education and practitioner training programs.

Keywords: information systems, requirements elicitation

Introduction

Requirements engineering starts with requirements elicitation. This paper initially looks at what research has told us about requirements elicitation and what we still need to know. A study is proposed to further our understanding. Firstly it is clear that requirements elicitation has not been done well and that failure causes considerable problems. In 2006 C. J. Davis, Fuller, Tremblay, & Berndt found "accurately capturing system requirements is the major factor in the failure of 90% of large software projects," echoing earlier work by Lindquist (2005) who concluded "poor requirements management can be attributed to 71 percent of software projects that fail; greater than bad technology, missed deadlines, and change management issues". The cost of this failure is enormous. Another study found that failed or abandoned systems cost $100 Billion in the USA alone in 2000 (Browne & Rogich, 2001). Not only does a failed system cost money, but fixing mistakes made at requirements

elicitation stage accounts for 75 percent of all error removal costs (Urquhart, 1999). What's hard about requirements elicitation? In comparing techniques for requirements elicitation a 2006 study suggested 22 different sources of difficulties with requirements (Table 1).

Table 1 – Problems with Requirements (adapted from (Tsumaki & Tamai, 2006)	
Incomplete requirements	Incomplete understanding of needs
Incomplete domain knowledge	Poor users' collaboration
Overlooking tacit assumptions	Incorrect requirements
Ill-defined system boundaries	Misunderstanding of system purpose
Ambiguous requirements	Synonymous and homonymous terms
Un-testable terms	Unnecessary design considerations
Inconsistent requirements	Non-solid intentions of requesters
Different views of different users	Unfixed requirements
Fluctuating requirements	Continuous acceptance of additional requirements
Excessive requirements	Unorganized bulky information sources
Too many requesters	Over-commitment by sales staff

This list covers problems that occur because communication between humans is fraught with difficulty, but also problems that arise because the needs of an organization change with time and with possibilities that people only notice after they start thinking about the project. Many of our information systems theories make the assumption that requirements are a stable set and we only have to be smart enough to find them. This ignores the reality that organizations are dynamic and needs can be created as opportunities arise. This paper concentrates on the difficulties associated with the communication between humans which is a necessary part of requirements elicitation.

How can We Find Requirements?

There are so many methods suggested for requirements elicitation and analysis that it is not instructive to list them all. Two authors make a sensible attempt at classifying the various techniques. Maiden and Rugg (1996) present the acquisition of requirements (ACRE) framework of 12 elicitation techniques (Table 2).

The 12 Acquisition of Requirements Techniques

Table 2. ACRE techniques (from (Maiden and Rugg 1996)	
Observation	Unstructured interviews
Structured interviews	Protocol analysis
Card Sorting	Laddering
Brainstorming	Rapid prototyping
Scenario analysis	RAD workshops
Ethnographic methods	Repertory grids

Which Requirements Elicitation Method is Best?

We are indebted to A. Davis, Dieste, Hickey, Juristo, and Moreno (2006) for a fairly comprehensive review of the research into requirements elicitation. This review classified research in terms of rigour and both the question being asked and the results of the research. Their review found some research results that were consistent enough to draw conclusions that might be generalized. These included:

- Structured interviews gather more information than unstructured interviews.
- Unstructured interviews gather more information than sorting and ranking techniques
- Interviewing is cited as the most popular requirements elicitation method

Method for this Study

Given that research efforts have found that interviews are the most effective way of obtaining requirements, an obvious research question is "what do we know about making interviews most effective?" Following the method of (A. Davis, Dieste, et al., 2006) a search of research publications was made in February 2007. 796 online databases were sampled which include ABI/Inform Global (ProQuest), Academic Research Library (ProQuest), APAFT: Australian Public Affairs – Full Text (Informit), Business Source Premier (EBSCO), Communication & Mass Media Complete (EBSCO), Emerald Management Xtra (Emerald), Expanded Academic ASAP (Gale), Factiva, ACM library and the IEEE Library. In addition Google scholar was used, which returned some thesis material not available through the databases. A search was made for refereed articles using the keywords "requirements", "information system requirements", "requirements analysis", "information systems + dialogue" and "interview." This returned 339 references. These were searched to determine which references concerned original research into requirements elicitation through interview. This process returned 24 papers. Each paper was then checked to see if any references were cited that had not become included in the list of research.

The research reported was intended to be collated using the same method as for A. Davis, Dieste, et al. (2006). It was found that there were no research outputs that had been replicated by independent teams. That is, research was followed up by the original author in a number of cases, but no new team had taken previous research and sought to extend it.

Results

Many authors purport to be talking about requirements elicitation, but quickly gloss over the issues and then perform research on one of the requirements analysis techniques. When these are discounted from the genuine original research list there are only three themes of research that remain. The following is an attempt to report the results of these streams of research.

A Model from Personal Construct Theory

C. J. Davis, Fuller, et al., 2006 present a four segment model (Figure 1) to illustrate some of the difficulties in Requirements Engineering (RE).
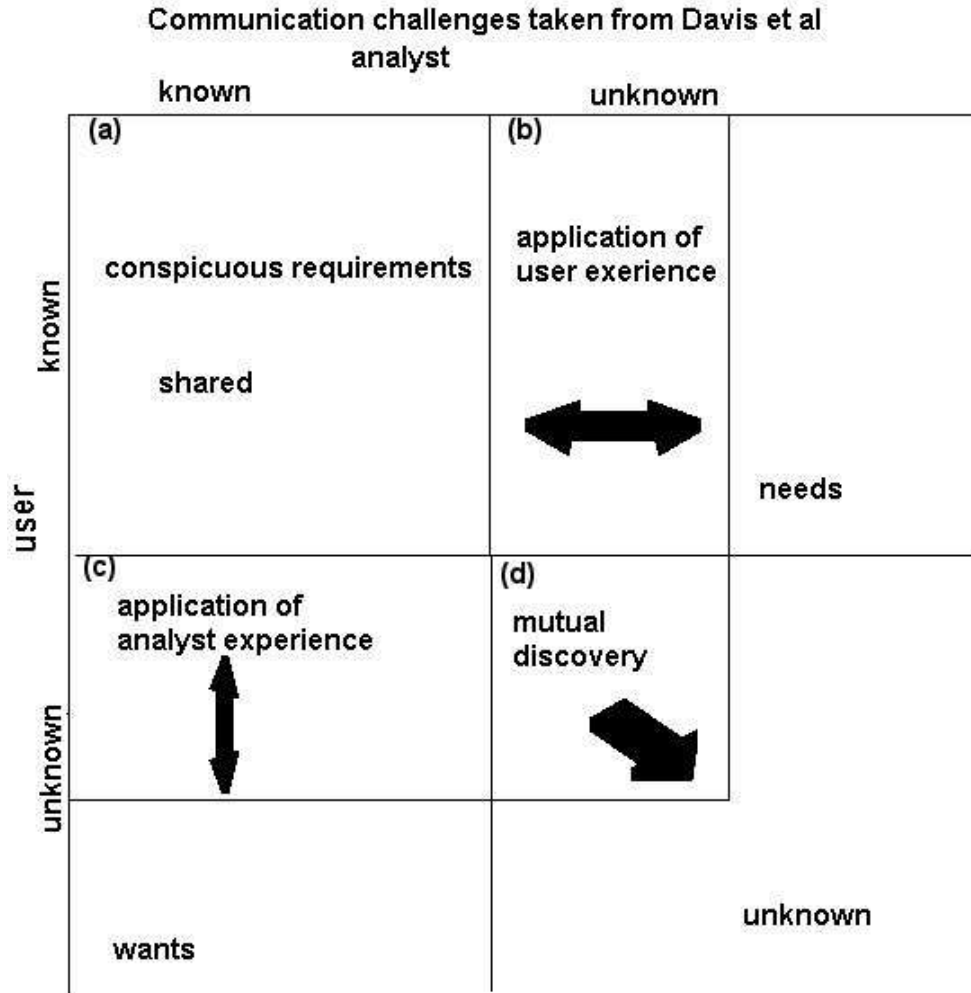
Communication challenges taken from Davis et al

Figure 1. Four Quadrant Model of the Difficulties in Requirements Engineering

Quadrant (a) represents that knowledge that is common to both analyst and client. Repeated interviews would hope to increase the size of this quadrant. Quadrant (c) represents that knowledge that the analyst has that the client does not yet. This would include knowledge of the analyst product and skills as well as that knowledge gained from education and training. The analyst would be seeking to teach the client part of this knowledge. Quadrant (b) represents knowledge that the client has but the analyst does not. This includes understanding of the unique business models of the client business. The analyst would seek to learn this knowledge from the client. Quadrant (d) represents new knowledge that will be created from the interaction of client and analyst.

It is assumed that the analyst can ask the questions and prod for more information and that the user can understand and answer the questions (C. J. Davis, Fuller, et al., 2006). Davis and the other advocates of diagramming techniques suggest that an analytical and communication tool is essential to venture into quadrant (d).

Cognitive Science

The second theme of research starts with theories of cognition. Cognitive science tells us that communication between people is hampered by the limitations of human cognition and by prob-

lems that arise when communication needs to be conducted by language. We can identify three classes of problems (Pitts & Browne, 2007):

> (1) limitations of humans as information processors;

> (2) the complex nature of requirements; and

> (3) the obstacles encountered in user and analyst interaction.

Research has been conducted into the interaction obstacles as recognized by culture and politics. There is also some work done on language difficulties arising because of terminology. The most fruitful has been research arising from applying theory of individual cognitive limitations to improving conversational performance and increasing elicitation outcomes. This work starts with an understanding of specific cognitive limitations of the way people's memory levels work. For example we can identify these cognitive limitations (Browne & Rogich, 2001):

- **Working memory**
  Capacity - People have limited capacity in working memory.

  Bounded rationality Because of cognitive limitations, people construct simplified models of problems.

- **Long-term memory**
  Difficulty in recall - People are unable to accurately recall everything from memory.

  Reconstructive nature - People reconstruct events from portions of memory.

- **Availability**
  Recency - People are influenced more by recent events than by events of the past.

  Ease of recall - People are more likely to remember events that are vivid.

- **Anchor and adjustment**
  Insufficient adjustment - People often make judgments by establishing an anchor and adjusting from that point; the adjustments are usually insufficient

  Overconfidence - People consistently exhibit overconfidence in their knowledge, even when their level of knowledge is poor.

- **Representativeness**
  Insensitivity to sample size - People do not consider the effects of sample size and draw faulty conclusions based on small samples

  Confirmation bias - People tend to seek only confirmatory evidence and fail to consider alternative hypotheses.

Several researchers have taken this theory and tried to find techniques for overcoming the cognitive difficulties. The most recent of these was research by Pitts and Browne (2007) who found that using procedural prompting strategies designed to overcome cognitive difficulties produced significantly better results than other prompting techniques.

Finally the area of cognitive science has been used to investigate stopping behavior. That is, the elicitation of requirements must eventually be called to a halt. Some work has been done by Pitts and Browne (2004) in determining what factors lead to a best choice of when to stop.

Education Theory

The process of requirements elicitation is often seen as a process of mutual education of consultant and client. Some researchers have taken current educational theory and applied it to improv-

ing elicitation. A strong theme of education theory is that learning takes place by interaction between people. This view leads to investigations of a technique called collaborative elaboration, in which two or more people interact in a conversation in a structured way. The interactions require participants to restate arguments in different ways and this involves some researchers in looking at the mental imagery that is used in the elaboration process. These streams of education theory have been tested in significant research efforts by:

- Collaborative elaboration – from education theory (Majchrzak, Beath, Lim, & Chin, 2005)
- Mental imagery (Zmud, Anthony, & Stair, 1993)
- collaborative requirements negotiation (EasyWinWin) – group communication theory (Grünbacher & Briggs, 2001).

The Missing Link

In every research test made that was uncovered by the literature review, researchers took theory from some other discipline and applied it to requirements elicitation. We can think of the research as applying treatments to requirements elicitation conversations to see if the treatment improves outcomes. The on-going problems with IS development projects as a result of poor requirements elicitation indicate that the treatments are not successful enough. As a result, one could ask the questions:

- Are the treatments addressing the essential components of conversations?
- Does a long list of effective treatments help a professional understand their role in conversations?

To understand these questions and to further understanding of conversations as part of requirements elicitation interviews we need to examine the fundamental nature of and approach to conducting requirements elicitation conversations. For example, hydrating cholera victims is very effective as a treatment, but sterilizing the water supply prevents the organism that is the disease. In our case a cursory look at preparing new staff to create requirements elicitation conversations shows that a RE conversation is not just one of:

- Overcoming cognitive difficulties
- Knowing when to stop
- Getting as many requirements as possible
- Seeking agreement and signing off
- Improving learning for client and consultant

C. J. Davis, Fuller, et al. (2006) tell us that "there is absolutely no agreement among experts on how best to elicit information or knowledge" and that most authors decry the "shortage of comparative studies analyzing the potential of one technique against the capabilities of others".

To improve understanding of requirements elicitation conversations we intend to parallel a change in research approach used in research into student learning in the early 1970s. Prior to 1970 understanding of student learning was at a similar impasse to current understanding of requirements elicitation interviews. Prior to 1970 educational researchers had observed students' learning behaviors and measured the quantity of learning outcomes. A relationship was discovered between certain behaviors and high quantity learning outcomes. Teaching approaches were designed which were considered likely to encourage successful learning behaviors. These approaches were then applied to classroom situations. These approaches turned out to be unsuccessful however. In the early 1970s researchers in Sweden decided to investigate students' perceptions of what learning was about and how they approached learning. This research became known as the student learning research and lead to a significant improvement in understanding of student learning. A strong relationship was found between how students experienced the nature of learn-

ing, how they consequently approached learning, and the quality of learning outcomes (depth of understanding rather than amount learnt).

Based on the findings of the student learning research it would seem reasonable that an improved understanding of requirements elicitation conversations could be gained by studying and influencing consultants' experiences of the nature of conversations and approach to conducting conversations.

Phenomenography

The research approach used to investigate students' perceptions in the student learning research became known as phenomenography and we intend to use this approach to further understanding of requirements elicitation conversations.

Phenomenographic research approaches were developed in the early 1970s to qualitatively investigate the different ways in which groups of individuals experienced (conceptualised, perceived or understood) phenomena in the world (Marton, 1994). Phenomenography takes a second order research perspective - the focus is on analysing other peoples' accounts of their experiences of phenomena. Data is commonly collected from small groups of people through individual, in-depth, semi-structured interviews about a particular phenomenon. The interview transcripts are combined and analysed to identify and describe the distinctly different ways in which the phenomenon can be experienced (Cope, 2002, 2006).

The results of many phenomenographic studies have shown that a phenomenon can be experienced in a limited number of qualitatively distinct ways (Marton & Booth, 1997). Of considerable importance, the research has found that the different ways of experiencing a phenomenon are related in a hierarchy of sophistication based on logical inclusiveness. More sophisticated experiences of a phenomenon are inclusive of less sophisticated experiences.

An example of a phenomenographic study that yielded useful results was that of Bruce (1994), who investigated the different ways that a dissertation literature review could be experienced. The outcome space was an inclusive hierarchy of 6 distinctly different ways of experiencing a literature review. From a less to a more sophisticated experience of a literature review (shallower to a deeper understanding) the hierarchy consisted of a search, a list, a survey, a vehicle for learning (a description of the current state of knowledge), a research facilitator (an identifier of holes in knowledge) and a report. The most sophisticated way of experiencing a literature review, the report, was found to be inclusive of all the other experiences. The experience of producing a report included a search of the literature to produce a list of relevant publications which were then critically surveyed to describe the current state of knowledge, in doing so facilitating research through identifying areas in which there is a lack of knowledge. In this example the study resulted in a deeper understanding of the components of a phenomenon and how they might be combined in a specific activity. This case shows the possible outcomes of Phenomenography and how they can be then applied in the studied phenomenon.

In some phenomenographic studies, analysis of the differences between the distinctly different ways of experiencing a phenomenon identified in a study has lead to the identification of aspects of the phenomenon that are critical to a deeper understanding. Unless an individual is aware of the critical aspects they are unlikely to hold a deep understanding of the phenomenon. An example of a critical aspect is evident in Bruce's 1994 study of the different ways of experiencing a dissertation literature review mentioned earlier. It would appear that the need to integrate the findings of many studies to describe current understanding is a critical aspect of a deeper understanding of the nature of a dissertation literature review. Without awareness of this aspect a literature review is likely to be experienced as a list of brief summaries of a number of relevant papers. This experience is unlikely to lead to an integrated description of current knowledge.

The Research We Need

We are proposing a phenomenographic study of IT consultants' experiences of requirements elicitation conversations. In particular we are interested in how the conversations themselves as a phenomenon are experienced (their nature) and how they are approached (conducted). The qualitative nature of a phenomenographic research approach is ideally suited to the study. If we want to understand the nature of a phenomenon like requirements elicitation conversations, quantitative methods fail at the stage of asking "quantities of what?" It is especially the case with conversations that the important issue is the relationship between the consultant and the conversation (the phenomenon). After all, the consultant's perception of the conversation and approach to conducting the conversations are all we can affect.

We would expect to be able to describe an inclusive hierarchy of distinctly different and increasingly sophisticated ways of experiencing the nature of conversations and approaches to conducting the conversations. Through analysis of the hierarchies we expect to identify critical aspects of requirements elicitation conversations and approach to conducting conversations. These critical aspects will then be used to inform IS education and IS practitioner training programs.

Conclusion

Requirements elicitation is an often poorly completed aspect of systems analysis. Mistakes made in elicitation have been shown many times to be major causes of systems failure or abandonment and this has a very large cost either in the complete loss or the expense of fixing mistakes. Research has found that interviews (conversations between clients and consultants) are the most effective way of eliciting requirements. Three knowledge domains have suggested methods to improve conversations; personal construct theory, cognitive theory and education theory. In each case some experimentation has been conducted to show that various treatments can improve performance. Measurement of outcomes across timelines stretching from 1982 to the present continue to show that requirements elicitation is problematic despite these research results. An argument has been mounted that research into the nature of conversations in the field is needed to make the next step. The methodology of Phenomenography has been identified as a particularly matching method of determining the nature of requirements elicitation conversations.

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Biographies

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