

The Impacts of Cognitive Elicitation Techniques in Requirement Elicitation Process

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Abstract

The most daunting task faced by RE is to understand the needs of stakeholders in more precise and complete ways. In RE, the end users desire for a system that may fulfill their needs but it is hard for them to describe these needs in more suitable and understandable manner due to the fact that the stakeholder's viewpoints about system are rapidly changing as a result of rising evolution in requirements, cultural and political changes, various communication paths, linguistic barriers and some other factors. We need some methodology or meticulous requirement elicitation techniques that derive the actual need of end user from the system. This research paper is intended that how cognitive psychology and its elicitation techniques helps in describing the needs of various stakeholders and provides a sense of understandability for both parties i.e. stakeholders and requirement Engineer in the requirement elicitation process. The cognitive psychology digs into the mind of stakeholder by capturing all requirements that required to be replicated the proposed system by applying various cognitive techniques like protocol analysis, laddering, card sorting and repertory grids. In this paper, the main focus is to highlight the importance of cognitive elicitation techniques along with their advantages and disadvantages and its impact upon the RE process.

Key Words: Cognitive Psychology, Requirement Engineering, Protocol Analysis, Laddering, Repertory Grids, Class Responsibility Collaboration

1. Introduction

The cognitive psychology encompasses various disciplines, methodologies and models in a bid to improve the process of requirement elicitation not only in RE but it also extends its applications in distributed requirement elicitation, where the role of cognitive informatics is important. The impact of cognitive psychology in RE has been revolutionary as it paved ways in collecting requirements and minimizing the problems that encountered in requirement elicitation. RE is the process of collecting requirements based on the needs of end user by unlocking those perspective on which the behavior of system will be built. For understanding the perspective of users about the proposed system, it is vital to collect every aspect and details of the proposed system and this is only possible due to the cognitive psychology. Cognitive psychology studies the thinking mind and the mental processes concerning the way people attend and gain information and how these information processing mechanisms affect human behavior[1]. The cognitive psychology contribute towards understanding the human mind effectively and it provides both practical and theoretical ground for requirement elicitation and modelling. Cognitive psychology provides an understanding of the difficulties people may have in describing their needs[2]. The cognitive psychology provides a group of elicitation techniques for requirements .i.e. Protocol Analysis, Laddering and Repertory Grid and Class Responsibility Collaboration (CRC) as shown in Figure 1. These techniques are originally used in knowledge based systems. The main purpose of these techniques is to provide requirement modelling and analysis based upon the psychological aspects of end users. The cognitive elicitation techniques are intended to infer the tacit knowledge of end users and overcome the shortcomings of existing traditional techniques like surveys, interviews, questionnaires etc.

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In the next section cognitive elicitation techniques are discussed in more details that how such techniques have affected the process of requirement elicitation in requirement engineering and how they help in collecting requirements from end user based on cognitive aspects like attentions, human thinking, understanding, interpretation, acquisition of knowledge, reasoning.

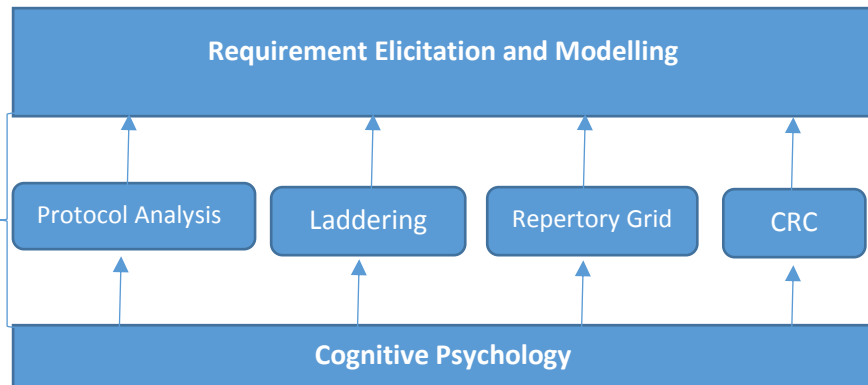


Figure 1. Cognitive Elicitation Techniques

2. Cognitive Elicitation Techniques

The main focus of such techniques is to thoroughly understand the problems and to provide a meaningful and relevant solution. The cognitive elicitation techniques for requirements can be divided into four types. In this section each technique has been discussed in light of working procedure, merits and demerits.

2.1. Protocol Analysis

Protocol Analysis is one of the cognitive elicitation techniques. In this technique, user is asked to think loudly while performing their tasks i.e. speaking out loud their ideas as they continue with their work. It is not a team-oriented approach rather it is an individual approach to the solution of the problem. The user is observed while he is engaged in work and at the same time he explains his thoughts and opinions regarding that. It helps to understand problem solving at an individual level i.e. how a person thinks about a problem and its solution to be[3]. According to Simson and Ericsson, the protocol analysis method follows the following procedure.

- a) The participants are instructed about the task and they are directed to think loudly like a person speaking to himself, alone in room
- b) The simple task like small mathematics calculation is given to solve with instruction to think aloud so that it can be heard
- c) In this method the participant verbalisation is recorded by using video or audio tape
- d) The tape contents are converted into written forms
- e) The written segments or forms are assigned to different categories
- f) Finally the protocol are used for analysis and model of information processing is established that is simulated in computer[3]

There are two approaches to data collection in protocol analysis: concurrent and retrospective[4, 5]. The concurrent protocol use the same approach as it has been discussed in the earlier section in stepwise manner. In retrospective protocol an interview is conducted and problem solver is asked to recall his activities. The whole interview is recorded with audio or video tape. While both concurrent protocol and retrospective protocol approaches share a common position that collected data can be

used to reconstruct the problem solving process, the latter is often seen as less intrusive to the process under observation [6].

The protocol analysis is recommended as requirement elicitation technique due to reasons such as, it is easy to be implemented for requirement elicitation. This method does not require any special arrangements, devices or instruments. It can be used without any budgetary constraints or financial constraints. The protocol analysis gives in depth knowledge about understanding the system domain. The protocol analysis is good but it still has some shortcomings i.e. it is time consuming and introspection is required, otherwise this technique will lead to unreliability [3].

2.2. Laddering

It was first introduced by the clinical psychologists in 1960 to understand the people “score values and beliefs [7]. In this technique, the first question is asked to know about the main attributes or features of the system. With the help of main attributes interviewer digs deeper with his skills to extract more information from users about criteria of their preferences[8]. The answers or requirements collected are arranged in hierarchal fashion or in form of ladders. This is why this technique is known as laddering. This techniques is intended to ask from the end user which attribute is the most important to him and why it is. The main idea is to get more valuable information and to know about the roots of the problem. This technique represents the requirements in hierarchical nature and can be easily understood [3]. This technique is tough and tedious for participants as there are some participants, who may unable to explain each time “why”. Addition or updating attribute can be somehow troublesome in this technique [3].

2.3. Repertory Grid

Repertory Grid technique was developed by George Kelly [9].This technique was initially developed for the purpose of diagnosing the psychiatric conditions and treatment of patients [10]. The repertory grid consists of matrix that contains four components or parts that are given as.

- a) **Topic**—Topic describes that interview is about what.
- c) **Elements** –The elements are used for representing people, object, events, experiences etc. The elements should be homogeneous[11]. So, people and objects should not be mixed. The elements should not be evaluative [12].
- c) **Ratings**---Ratings are given to the construct based upon different rating scales[12]
- d) **Constructs**---This is the most important component of the grid. In this the elements are compared in order to produce the statement that what interviewer thinks about [13].

RGT is consisted four stages such pre-interview, interview, post interview and analysis as shown in Figure 2 [13].

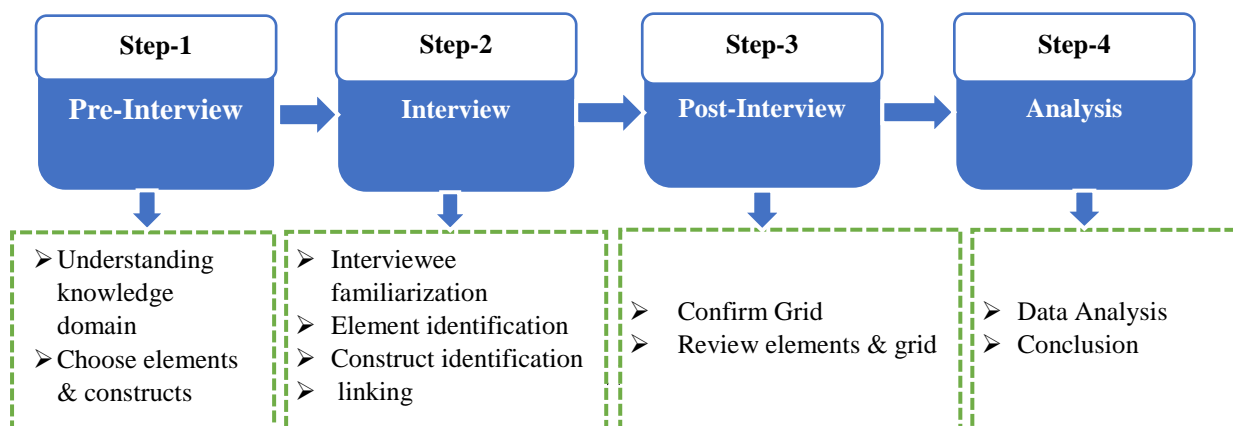


Figure 2. RGT procedure

This technique is best to use for Requirement elicitation as it differentiates between differences and similarities and it has the ability of minimizing the bias when developer comes to understand the domain from the perspective of user. This technique is time consuming and it requires a huge amount of efforts on the part of analyst and expert [3]. There are many variations of design and it becomes difficult to choose the right one [9].

2.4. Class Responsibility Collaboration

Class Responsibility Collaboration (CRC) techniques was presented by Kent Beck and Ward Cunningham in 1989. It is modelling techniques in which collection of cards are used and each card is composed of three element i.e. class, responsibility and collaboration. Class can be a collection of objects having similar nature, responsibility describes function and collaboration shows the relationship among the classes [3]. Initially, CRC techniques were used for teaching OOP techniques but they can also be used for modelling [14]. The simple layout of CRC card is shown Figure 3.



Figure 3. CRC Structure

A hand written CRC card of customer and order is shown in Figure 4. Customer is the class and its functionality or responsibility is given below customer and order is collaborator.

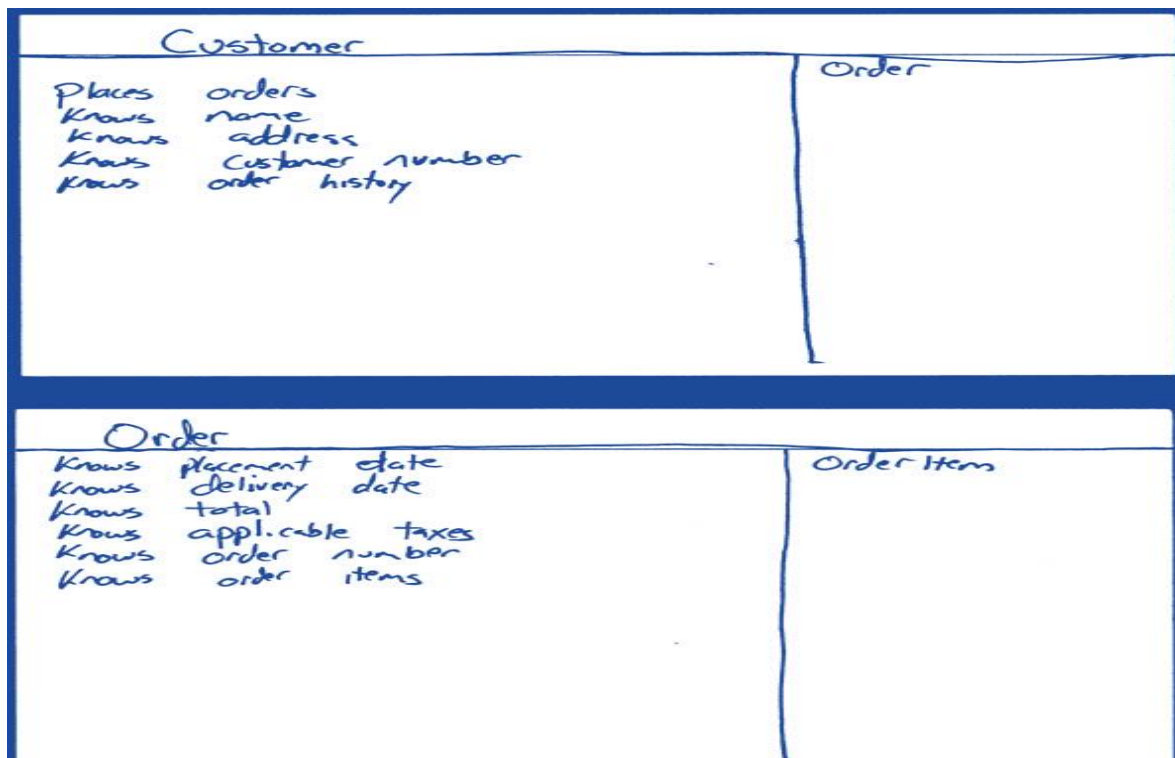


Figure 4. Template of CRC

The CRC has many advantage in RE process like it can be used in place of UML diagram, it uses natural language and it gives a chance to both user and expert to develop a model [3]. This techniques has shortcomings of providing limited detail about software, not suitable for large and complex system, and it is time consuming and difficult [3]. The details of all these cognitive elicitation techniques along with theirs's strength and weaknesses are depicted in Table 1.

Table 1. Cognitive elicitation techniques

Technique	Ref No.	Authors	Strengths	Weakness
Protocol Analysis	[15] [3] [16]	<ul style="list-style-type: none"> • Austin et. al • Yousuf, et.al 	<ul style="list-style-type: none"> • Helps in understanding the internal mind state • Easy to implement • No special arrangement • No financial constraint 	<ul style="list-style-type: none"> • No true process representation • Time consuming • Needs introspection • Sometimes unreliable
Laddering	[3] [17] [18]	<ul style="list-style-type: none"> • Yousuf et.al • T. Grubert. 	<ul style="list-style-type: none"> • Represents information in hierarchal • Understands the root of problem • More information about problem 	<ul style="list-style-type: none"> • Tedious • Asking every time "why" can be boring • Answering down the ladder can be difficult • Long and tiring • Updating attribute is troublesome
RGT	[13] [3] [16]	<ul style="list-style-type: none"> • Austin et. al • Yousuf, et. al • CuCtis et. al 	<ul style="list-style-type: none"> • Easy to administer • Structured • Low budget • Minimizes biasness 	<ul style="list-style-type: none"> • Not good for complex requirements • Requires great effort
CRC	[3] [19]	<ul style="list-style-type: none"> • Yousuf, et. al • Tariq et.al 	<ul style="list-style-type: none"> • Uses natural language • Used as UML diagram 	<ul style="list-style-type: none"> • Not suitable for large system • Time consuming • Difficult • Only high level of abstraction

3. Conclusion

From above discussion it is clear that cognitive elicitation techniques provide various means in order to capture the requirements of stakeholders and can be used in scenarios, where, end users fail to state the requirement in complete and accurate fashion. Cognitive elicitation techniques provide a platform about the internal mind of stakeholders and can be used in different situations based upon the needs and situations. The cognitive elicitation techniques are also budget friendly and can easily be administered. They provide information to the requirement engineers that can be easily used for

making decisions. These techniques represent the information in more meaningful manner and they do not require and special arrangement for conducting. These are very simple and more ideal for knowledge based systems. These techniques are more profitable, if used properly and can improve the requirement elicitation process due to encompassing the various advantages.

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