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# THE ROLE OF DOMAIN KNOWLEDGE IN REQUIREMENTS ELICITATION: AN EXPLORATORY STUDY

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# THE ROLE OF DOMAIN KNOWLEDGE IN REQUIREMENTS ELICITATION: AN EXPLORATORY STUDY

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## Abstract

*Requirements elicitation is the first activity in the requirements engineering process. It includes learning, surfacing and discovering the requirements of the stakeholders of the developed system. The elicitation process involves actors of different roles, backgrounds and domain knowledge. Therefore, it is a communication-intensive process. Overcoming communication barriers between analysts and stakeholders, partly caused by a gap in their domain knowledge, is essential. Various elicitation techniques exist for helping analysts extract the requirements from the different stakeholders. During the elicitation process, the analysts are not limited to one specific technique and can use different techniques according to the situation, time and resources available.*

*Analysts may have domain knowledge prior to the elicitation process. This prior knowledge may have an impact on the elicitation process, affecting the analysts' decisions and conduct within it. This paper reports an exploratory study in which the perceived and actual effects of prior domain knowledge on the requirements elicitation process were examined. The results indicate that domain knowledge clearly affects the elicitation process and the way the analysts conduct the elicitation. The findings provide insights as to both positive and negative effects of domain knowledge on requirements elicitation, as perceived by participants with and without domain knowledge. Furthermore, these insights can be utilized in practice for supporting analysts in the elicitation process and for forming requirements analysis teams. They highlight the different contributions that can be provided by analysts with different levels of domain knowledge in requirements analysis teams and the synergy that can be gained by forming heterogeneous teams of analysts with and without domain knowledge.*

*Keywords: Requirements elicitation process, Requirements elicitation techniques, Domain knowledge*

# 1 INTRODUCTION

Requirements elicitation is the first activity in the requirements engineering process. It includes learning, uncovering, surfacing and discovering the needs (requirements) of the stakeholders of the system to be (Nuseibeh & Easterbrook 2000, Hickey & Davis 2004, Pitts & Browne 2007). The information elicited during this process needs to be interpreted, analyzed, modeled and validated before the analysts can feel confident enough of the requirements' completeness and correctness (Nuseibeh & Easterbrook 2000).

There are various elicitation techniques to help the analysts extract requirements from the different stakeholders; the most common one is the interview technique (Bostrom 1984, Friedrich & Van Der Poll 2007, Hofmann & Lehner 2001, Davis 1982, Agarwal & Tanniru 1990, Watson & Frolick 1993, Browne & Rogich 2001). The analysts are not limited to one specific technique and can use different techniques according to the situation and the time and resources available (Nuseibeh & Easterbrook 2000, Kassel & Malloy 2003). As the elicitation process involves different stakeholders, it is a communication-intensive process (Coughlan & Macredie 2002), in which human interactions play an important role (Kassel & Malloy 2003). This also leads to one of the challenges of the elicitation process, which is to overcome the communication barrier between analysts and stakeholders, partly caused by a gap in their domain knowledge (Van Buren & Cook 1998). In this context, it seems beneficial for an analyst to possess domain knowledge prior to the elicitation. When an analyst works and develops a number of systems in the same domain, knowledge gained in previous projects can be used and may help in requirements determination for the current project.

However, prior domain knowledge might also have negative effects. Studies in the field of Psychology (Wiley 1998) show that domain knowledge may cause a tendency to approach situations in ways that have worked in the past and lead to fixation in problem solving. Their reported experiments show that when solving a creative problem, domain knowledge not only biases a first solution attempt, but also fixates the high-knowledge subjects to a narrowed search space, which decreases their chances of finding an appropriate and correct solution. Furthermore, warning the subjects not to use their previously gained knowledge for solving the new problem did not improve their performance on misleading items, while subjects with low levels of knowledge (but not lacking knowledge entirely) were more flexible in their way of thinking, and reached correct solutions more often than the most knowledgeable subjects.

In our context, this raises the question of what the effect of prior domain knowledge on the requirements elicitation process is. This issue has been initially addressed by Berry (1995, 2002a, 2002b), who, based on his own experiences, indicated the importance of the lack of domain knowledge (i.e. ignorance) in RE. In (Berry, 2002a) he noted that the same observation was made by Burkinshaw in 1969 (Buxton & Randell, 1969). Berry argues that including a smart ignoramus analyst in the RE team is important to the success of system development. The ignoramus, who has no assumptions about the domain, is more capable of spotting inconsistencies and asking questions whenever he or she catches a sign of something left unsaid. Berry also argues that the team must include at least one expert, who can provide the relevant information and facts.

In order to broaden and deepen the understanding of the effects of prior domain knowledge on the requirements elicitation process, this paper reports a study concerning the perceived and actual effect of domain knowledge on requirements elicitation. Requirements elicitation may involve a number of techniques, such as interviewing the stakeholders, observing their work, employing questionnaires, etc. This study focused on the interview technique, which has been identified by many researchers as a substantial and leading technique (e.g., Bostrom 1984, Friedrich & Van Der Poll 2007, Hofmann &

Lehner 2001, Davis 1982, Agarwal & Tanniru 1990, Watson & Frolick 1993, Browne & Rogich 2001, Davis et al. 2001). However, we also investigated the effect of domain knowledge on other techniques. Since the possible effects can be at different directions, our study is exploratory in nature, makes no a-priori assumptions, and employs a qualitative research approach.

The main research questions were the following:

*Research question 1:* What are the perceived positive and negative effects of domain knowledge on the requirements elicitation process?

The rationale for this question is that while domain knowledge is usually perceived as contributing to requirements elicitation, it might have negative effects as well. An analyst who considers herself as a domain expert might be biased and tend to rely on her knowledge rather than be attentive to the stakeholder. In addition, as Berry (1995) argues from his observations, domain experts fall too easily for tacit assumptions. The aim of investigating this question is to understand the different aspects in which prior domain knowledge may influence the way an analyst conducts elicitation, according to the participants' perceptions.

*Research question 2:* In what ways are the perceptions of these effects different for various elicitation techniques and for analysts that have different levels of domain knowledge?

The rationale for this question is twofold. First, domain knowledge may differently affect the various elicitation techniques. Understanding these differences may provide guidance as to which elicitation technique should be applied and how, given the level of domain knowledge held by the analyst. Second, while the perception of the effect by analysts that have domain knowledge is based on actual experience in applying this knowledge, the perception of analysts who lack domain knowledge is based on the difficulties they experience and on their expectations regarding how domain knowledge could help with these difficulties. Analyzing the different perceptions can highlight the difficulties incurred by analysts who lack domain knowledge, and provide guidance in addressing these difficulties.

*Research question 3:* What is the effect of domain knowledge on the selection of elicitation technique?

While research question 2 explores how applying the different elicitation techniques is experienced, this question directly addresses the conclusion that can be drawn from this experience, namely the choice of preferred technique. Based on the expected differences in how analysts with and without domain knowledge experience the different techniques, we expect the choice to be different for these two groups.

*Research question 4:* What is the effect of domain knowledge on the actual course of interviews?

While the first three questions address perceptions of analysts and their consequences (choice of technique), this question aims at exploring the actual effects of domain knowledge on the conducted interview. It focuses on the interview technique for two reasons. First, as mentioned, this is a major and important technique (e.g., Davis et al. 2001), and second, it is possible to analyze the questions posed by the analysts as they were recorded. Our expectation was that domain knowledge would lead to more detailed and focused questions.

In the remainder of the paper, Section 2 presents the methodology and setting of the study, whose findings are presented in Section 3. The findings are discussed in Section 4, and conclusions are given in Section 5.

## **2 RESEARCH METHODOLOGY AND SETTINGS**

The aim of the study was to gain an understanding of the perceived and actual effect of prior domain knowledge on the requirements elicitation process. As mentioned, the research is of an exploratory nature; hence we applied a qualitative research approach. In particular, we used the grounded theory approach (Strauss & Corbin 1990), in which the research questions were examined through the eyes of the participants. Accordingly, tools from this approach were used to collect and analyze the data. Specifically, the study's participants were interviewed, they filled out reflection questionnaires, and they handed in written reports regarding their elicitation experience and outcomes in each elicitation technique they used. In addition, relevant class discussions were observed. All the interviews and observations were transcribed. The textual data were broken down into atomic segments, which were closely examined, compared, conceptualized and categorized. A more detailed description of the data collection and analysis is presented later in this section.

## 2.1 Settings

The study was conducted in a university Requirements Analysis course, given to last year MIS students. As a graduation project in MIS, the students are required to develop an information system for a real customer of their choice. The system development takes place during the final year of their studies, and is done by teams of 2-3 students. Each Student who participates in the course "Requirements Analysis Seminar" in parallel to the graduation project is required, as part of the course assignments, to submit reports describing his or her experience in applying the different elicitation techniques, which are covered in the course. These reports include information about the data and the requirements which were elicited from the client and relevant stakeholders. They also include a description of the difficulties the student has encountered during the elicitation process, and of the way he or she has coped with these difficulties.

The study included two iterations, which had similar structures but took place a year apart from each other with different groups of participants. The first iteration included 31 participants, and the second iteration included 38 participants. Conducting the study in two iterations gave further validation to its findings.

Each iteration included the following main phases:

1. After the students had studied a specific elicitation technique in class, each of them was required to apply this technique in the field (his or her graduation project), and use it to elicit information from his or her client and relevant stakeholders. Each student was also required to submit a report which described his or her experience in applying this technique. The report included information about the data and the requirements which were elicited. It also included a description of the difficulties that he or she had encountered during the elicitation, and of the way he or she had coped with these difficulties. The submitted assignments (reports) included: interview, planning game (PG)<sup>1</sup>, observation, and questionnaire<sup>2</sup>. Each of these assignments was submitted either by a single student or by the project's team, in which case the assignment was multiplied by the number of team members (e.g., in the interview assignment, a team of two students conducted, and reported on, two interviews).
2. Each participant was asked to fill out a reflection questionnaire about his or her experience during the elicitation process, and particularly about the effect of his or her prior domain knowledge on the process. As part of the questionnaire each participant was asked to rank his or her domain knowledge in the beginning of the project (i.e. before he or she started the elicitation process). The data which were collected throughout this study were analyzed according to these ranks.
3. During the final presentation of their projects, each participant was interviewed by one of the researchers about the elicitation process, about the difficulties which he or she has encountered, and

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<sup>1</sup> The PG assignment was collected only in the second iteration when the students learned agile techniques.

<sup>2</sup> Each participant of the first iteration was required to submit either the observation assignment or the questionnaire assignment. In the second iteration each participant was required to submit both assignments.

about the effect of his or her domain knowledge on the elicitation process. These interviews were also used to verify the information obtained in the previous phases of the field study.

The analysis of the data which were collected during the first iteration raised further questions and issues to cover, and the second iteration was refined accordingly. For example, while the questionnaire in the first iteration focused on the interview with the client, the questionnaire in the second iteration referred also to additional elicitation techniques they had used.

## **2.2 Data collection and analysis**

The data collected throughout the study included: (a) the reports handed in by the students summarizing their experience with the different elicitation techniques, (b) the reflection questionnaires that relate to domain knowledge, (c) the interviews made with the students, and (d) observations of class discussions.

The data were analyzed following the grounded theory approach (Strauss & Corbin 1990), as described above.

Addressing the first research question: “what are the perceived positive and negative effects of domain knowledge on the requirements elicitation process?”, textual phrases from all data sources (but mostly (b) and (c)) were categorized and codified to identify classes of perceived advantages and disadvantages of prior domain knowledge in the elicitation process. To get some quantification of the relative importance of these categories, we counted the number of quotes belonging to each category in the data.

Addressing the second research question: “in what ways are the perceptions of this effect different for different elicitation techniques and for analysts that have different levels of domain knowledge?”, we classified the quotes (statements) based on the level of domain knowledge of the student who made them, as indicated in the questionnaires. We related to two levels of this factor, namely students with and without prior domain knowledge<sup>3</sup>. We were then able to count the number of quotes in each category for the two levels of domain knowledge. Accordingly, we have examined how the level of domain knowledge influences the ways in which the participants perceive the effects of domain knowledge, and in what ways the perception of these effects is different for different elicitation techniques.

Addressing the third research question: “what is the effect of domain knowledge on the selection of elicitation technique?”, we mainly relied on the reflection questionnaires and the interviews, where the students were asked about their preferred choice of elicitation technique. We analyzed their response based on their level of domain knowledge.

Finally, addressing the fourth research question: “what is the effect of domain knowledge on the actual course of interviews?”, we relied on all sources of data, analyzing the reported difficulties in the experience reports (i.e. the interview assignment in which the students described their experience in applying the interview techniques), the elicitation information in these reports (e.g., plans and summaries of interviews with stakeholders), as well as the information from the reflection questionnaires and interviews.

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<sup>3</sup> Naturally, the amount of prior domain knowledge one holds is continuous in nature. We divided it to these two discrete levels in this study for the sake of simplicity.

### 3 RESEARCH FINDINGS

This section presents the findings of the study. We start by addressing the first and second research questions of *perceived* advantages and disadvantages of domain knowledge in the elicitation tasks. Afterwards, we address the third and fourth questions, relating to the *actual effect* on the selection and use of different elicitation techniques.

#### 3.1 Perceived effects of domain knowledge

As explained above, we categorized statements collected from the students through the different data collection techniques into a list of advantages and disadvantages of domain knowledge in requirements elicitation, and counted the number of quotes (statements) in each category as an indication of their relative importance. These were analyzed separately for the different elicitation techniques, while considering the level of domain knowledge of the students who made the statements. Table 1 provides the statements that indicate positive effects or advantages of domain knowledge (DK), which were obtained from the data relating to the interview assignment.

Perceived advantage	Statements of students with DK	Statements of students without DK	Total
Helps to phrase focused questions	31	8	39
Provides a common language with the client	5	10	15
Helps to know what to focus on	13	0	13
Helps to understand the client	6	2	8
Helps to predict the client's answers	2	5	7
Saves time learning the basics	3	3	6
Helps to cover all the relevant issues	3	2	5
Enables to provide information to other team members	1	3	4
Helps to know what to improve / preserve	3	0	3
Helps to direct the interview	0	2	2

Table 1. Positive effects of domain knowledge indicated for the interview assignment

As seen in the table, the most dominant effect of domain knowledge that was indicated was its help in phrasing focused questions. It was mainly indicated by students, who had domain knowledge, but also, to a lesser extent, by students who did not have knowledge. The rationale of this effect is that, being familiar with the domain, the issues to be addressed as well as the terminology are known to the analyst. Hence, the analyst can more easily prepare questions for an interview. A typical statement referring to this advantage is: "The questions were phrased based on my familiarity with the domain and with systems for managing it, therefore the questions were comprehensive and to the point".

The two following advantages are related to the first one, but are more specific. The claim that domain knowledge provides a common language with the client was mainly made by participants without domain knowledge, who were not familiar with the domain terminology and apparently felt the need for it. The effect of domain knowledge in knowing what to focus on was indicated only by students that had domain knowledge, who experienced this effect not only in phrasing the questions but also in interpreting the answers given during the interview and knowing which relevant issues they need to address.

Two advantages that relate to domain knowledge as supporting control over the interview were mainly indicated by students without domain knowledge: "helps to predict the client's answers" and "helps to

direct the interview”. However, only students with domain knowledge mentioned that it helps to know what to improve or preserve (with respect to the current situation).

In summary, our findings indicate that analysts without domain knowledge are more concerned about how to communicate with the interviewee, gain mutual understanding and direct the interview, and believe that this is where domain knowledge can help. In contrast, those who have domain knowledge use it for planning and conducting a focused interview, taking a proactive approach including improvement directions. It should also be noted that some students (mainly without domain knowledge) indicated that teamwork of students with and without domain knowledge was helpful – those with domain knowledge provided the other team members the necessary information about the domain, while those who lack domain knowledge provided a fresh and objective point of view.

Considering the observation technique, Table 2 lists the statements assessing the perceived advantages of domain knowledge as reflected in the data collected.

Perceived advantage	Statements of students with DK	Statements of students without DK	Total
Provides a common language with the client	0	1	1
Helps to know what to focus on	2	14	16
Saves time learning the basics	1	0	1

*Table 2. Positive effects of domain knowledge indicated for the observation assignment*

Most of these statements related to the help of domain knowledge in knowing what to focus on, and were made mainly by students without domain knowledge. Apparently, conducting observations when the processes are not familiar to the observer is a hard task, and students without domain knowledge felt lost. A typical statement made by these students was: “since it is the first observation and there is not enough knowledge about the procedure under discussion, it is not possible to decide in advance on all the criteria [regarding what exactly to observe]”.

Interestingly, knowing what to focus on was indicated as an advantage of domain knowledge by students with domain knowledge in the interview assignment, and oppositely here – it was indicated by students without domain knowledge. A possible explanation is that when preparing the interview students with domain knowledge felt it was helping them to focus, while students without domain knowledge were looking for a more general understanding and were concerned by terminology and communication issues. In the observation assignment, overwhelmed with a large amount of information, domain knowledge was needed for being able to focus on the important details.

Finally, considering the questionnaire technique, Table 3 provides the statements collected.

Perceived advantage	Statements of students with DK	Statements of students without DK	Total
Helps to phrase focused questions	4	1	5
Helps to phrase understandable questions	1	0	1
Helps to know what to focus on	1	0	1
Helps to cover all the relevant issues	2	0	2

*Table 3: Positive effects of domain knowledge indicated for the questionnaire assignment*

Similarly to the findings that concern the interview assignment, in the questionnaire assignment the emphasis was on the advantage 'Helps to phrase focused questions'. Preparing questions for a



questionnaire is similar to preparing questions for an interview. Therefore, the importance of domain knowledge in phrasing and focusing the questions is emphasized here as well.

It is interesting to see that in the questionnaire assignments, only participants with domain knowledge referred to the advantages 'Helps to cover all the relevant issues', while in the interview it was also mentioned by participants without domain knowledge. A possible explanation is that during the preparation of the questionnaire, as the participants need to decide on the issues to address in the questionnaire, those with domain knowledge noticed (and accordingly indicated) that they were using their domain knowledge to make sure that all the relevant issues were covered in the questionnaire. In contrast, those who lack domain knowledge lack the ability to know they were missing issues in the questionnaire.

The data analysis also yielded statements indicating perceived negative effects of domain knowledge. These were fewer than the indicated advantages; hence we combined all the statements without separating the elicitation techniques. Table 4 provides the statements addressing the disadvantages of domain knowledge.

Perceived disadvantage	Statements of students with DK	Statements of students without DK	Total
Fixed point of view	5	2	7
Missing information due to perceiving questions as trivial	3	0	3
Contradictions in the points of view	3	0	3

*Table 4: Perceived negative effects of domain knowledge*

The table clearly indicates that disadvantages of domain knowledge were mainly indicated by participants that have domain knowledge. These were derived from difficulties they experienced through the elicitation process. The participants that lack domain knowledge could not, in most cases, even perceive these kinds of difficulties.

The negative effect that was mostly indicated was a fixed point of view. A typical statement indicating this effect is: "Domain knowledge builds stigmas and therefore there is a certain difficulty in observing the organization objectively". This finding is consistent with the findings discussed in the introduction (Wiley 1998) of domain knowledge as causing fixation in problem solving.

The second negative effect that was indicated was missing information due to perceiving questions as trivial. One of the students wrote: "I did not ask trivial questions. Looking back, maybe there was room for that... since I did not ask, I have basically decided the answer for the client, when his actual answer might have been different." This stands in contrast to the perception of domain knowledge as contributing to the completeness by helping the analyst to cover all issues. It is also consistent with the recommendation of Berry (Berry 1995, Berry 2002a, Berry 2002b) to include a smart ignoramus in the RE team, whose role is to ask the so-called ignorant (not stupid) questions that expose tacit assumptions that are incorrect. We may hence conclude that the effects of domain knowledge on completeness and correctness are not certain to be positive.

The third negative effect mentioned is a possible contradiction in the views of the stakeholder and the analyst. This occurs in situations where the information given (by the stakeholder) contradicts the knowledge the analyst has about the domain. It can also occur when the analyst, based on his knowledge of the domain, has his own view about the system and its requirements, which might contradict the stakeholder's view. This is a difficulty with which the analyst has to deal, but it can also be used for

verifying the information given by the stakeholder, or for suggesting new ideas to the stakeholder (i.e. the analyst takes a proactive approach, suggesting improvement ideas), and eventually bear positive results.

### 3.2 Elicitation technique selection

The third research question we addressed related to the effect of domain knowledge on the selection of elicitation technique to use. In our study, the students did not have this choice. Rather, each student had to use at least once each of the following techniques: interview, observation, questionnaire, and planning game (in the first iteration of the study the students could choose to use either observation or questionnaire, in addition to the interview technique). They were then asked about what technique or combination of techniques were most effective. The distribution of their answers (in percentage) is given in Table 5. The percentages were calculated according to the 3 main techniques which were selected as the most effective. As some of the students selected a combination of techniques (i.e. 2 out of these 3 main techniques), these percentages were also calculated and are presented under the relevant technique. In cases where students selected 2 out of the 3 main techniques, each was included in the percentages of the other (i.e. under 'Combined with another technique'), and it is considered an overlap. The PG was only selected once in a combination with another technique – the interview technique, by a student without domain knowledge. The observation technique was either selected alone as the most effective, or combined with the interview technique. The percentages in the following table reflect these selections.

Elicitation technique		Participants with DK	Participants without DK
Interview	Alone	58.3%	76.2%
	Combined with another technique	25%	14.3%
Observation	Alone	8.3%	9.5%
	Combined with another technique	25%	9.5%
Planning game	Alone	8.3%	0%
	Combined with another technique	0%	4.8%

*Table 5. The most effective elicitation technique as indicated by the participants*

It is clear from the table that the interview is the leading technique, perceived as the most effective one. However, while participants who lack domain knowledge tend heavily to rely on it, those that have domain knowledge are more willing to combine it with other techniques, particularly with observations. As reported above, the participants who lack domain knowledge had difficulties in applying the observation technique, and this is reflected in the choices they made as to which technique is the most effective one.

### 3.3 Effect on the actual interview

To study the actual effect of domain knowledge on the course of the interview, we analyzed the questions that were formed and presented by the students to the interviewees (as reported in the interview assignment). We classified the interview reports to three groups: interviews that included only general questions (that could be asked for almost any kind of system), interviews that had both general and specific questions (questions that relate to details of the processes to be supported by the system), and interviews that had mostly specific questions. Table 6 presents the percentage of these classes for participants with and without domain knowledge.

Type of questions	Participants with DK	Participants without DK
All general questions	22%	69%

Some specific questions	11%	31%
Mostly specific questions	67%	0%

*Table 6. Interview classification*

As seen in the table, while participants that lack domain knowledge mostly asked general questions, those that have domain knowledge could go deeper and reveal details. This is consistent with some of the previous reported findings. Asking general questions is a way for analysts who lack domain knowledge to learn the basics (perceived advantage of domain knowledge: saves time of learning the basics). Asking specific questions is possible for analysts that have domain knowledge since they know what to focus on (perceived advantage). Asking less general questions by participants with domain knowledge might also lead to the perceived disadvantage of missing information due to perceiving questions as trivial. By not asking trivial questions and so-called stupid questions, the analysts might miss tacit assumptions and inconsistencies in them (Berry 1995, Berry 2002a, Berry 2002b).

## 4 DISCUSSION

The findings of the study, although mostly relating to the perceived effect of domain knowledge on requirements elicitation, can provide some understanding of the actual effect.

Communication support: Our findings show that domain knowledge supports the communication between the analyst and the stakeholders. Specifically, using the domain terminology enables the analyst to present questions that are understandable by the stakeholders and to precisely understand the answers that are given.

Requirements completeness: domain knowledge supports completeness of the requirements since it enables the analyst to know which issues need to be covered. It is as if the analyst has a general picture in mind, and tries to find out the specific details. With this picture, the analyst may ask questions about issues that the stakeholder might have forgotten otherwise. In contrast, an analyst that lacks domain knowledge does not have this general picture, and will have to rely on the information given by the stakeholder without knowing if this is all the information required. However, domain knowledge may also negatively affect completeness, since the analyst may neglect to ask questions whose answer seems obvious. Speaking of a picture, one might think of the following picture metaphor: a knowledgeable analyst might not ask what the color of the sky is, taking for granted it is blue, while in this particular picture it might be grey.

Elicitation focus: As our findings indicate, an analyst without domain knowledge would need to put much of the effort into learning the basics of the domain, and is mainly concerned with completeness issues (not knowing what information is still missing) and communicating with the stakeholder. An analyst that has domain knowledge can focus on the specific details, knowing how they fit into the overall puzzle. He can take a proactive elicitation approach, suggesting improvement ideas and verifying the information given against his prior knowledge.

Bias and fixation: Domain knowledge may cause bias and fixation in the analyst's view and interpretation of the information given by the stakeholder. This can relate to priorities among requirements as well as to specific perceptions on how the processes should be performed and managed. If the information given is contradictory to the knowledge the analyst has, this knowledge may be used for verifying this information through further questions. Alternatively, the analyst may impose his own view.

The choice of elicitation technique: It is clear from our findings that observations are difficult to perform and are of limited effectiveness when the analyst does not have prior domain knowledge. This does not mean they should be avoided. Rather, observations can be conducted when some understanding of the domain has already been gained. Hence, when the analyst lacks domain knowledge, it is preferable to start with other techniques, most notably interviews, and only then consider observations.

Main implications for practice: these can relate to how to support analysts that lack domain knowledge, and teamwork of several analysts. To support the communication with the stakeholders, it may be advised that analysts without domain knowledge would learn the domain terminology before the elicitation sessions. Other preparations may include reviewing existing systems in the domain to enrich the domain knowledge and provide the analysts with a sense of completeness. When the elicitation is performed by a team of analysts, a combination of different levels of domain knowledge can be beneficial, as suggested by Berry (Berry 1995, Berry 2002a, Berry 2002b). The analysts that have domain knowledge can facilitate communication, focus on details, and promote a proactive approach, while the analysts that lack domain knowledge have the role of preventing fixation and taking information for granted. Note that according to our findings the disadvantages of domain knowledge are mostly not recognized by analysts who lack it. Hence, the important role of the less knowledgeable analysts should be highlighted.

Two main limitations of the study should be noted. First, the study's participants were students, who are not experienced analysts. Their limited experience in performing elicitation might have been reflected in the way they performed the tasks and in their perceptions of the effect of domain knowledge. In addition, even when a student claimed to have domain knowledge, this knowledge might have been limited as compared to the knowledge of experienced analysts. As well, when an experienced analyst lacks knowledge in a specific domain, he may still apply knowledge gained in other domains by making an analogy, as opposed to students who have not gained much experience.

Second, the study took a qualitative research approach with attempted quantification of importance based on the number of quotes given for each statement category. This quantification can only be regarded as indications to the relative importance of the categories rather than as corroborated claims. Future research may take a more quantitative approach designed based on the findings of this exploratory study.

## 5 CONCLUSIONS

Domain knowledge clearly affects the way analysts conduct the requirements elicitation process. The study reported in this paper sought to gain an understanding of this effect. This was achieved mainly by investigating how it is perceived by analysts with and without domain knowledge for different elicitation techniques. In addition, we investigated the actual effect of domain knowledge on conducting interviews and on the preferences of different elicitation techniques throughout the elicitation process.

The findings of the study provide insights as to both positive and negative effects of domain knowledge on requirements elicitation. Furthermore, these insights can be utilized in practice for supporting analysts in the elicitation process and for forming elicitation teams. They highlight the different roles that can be played by analysts with different levels of domain knowledge in requirements analysis teams and the synergy that can be gained by forming teams of analysts with and without domain knowledge.

Since this study is exploratory, it could only indicate the existence and provide a description of phenomena that should be further investigated. Future research can build on the findings of this study and formulate hypotheses that can be quantitatively corroborated. These will establish our understanding of the effects of domain knowledge on requirements elicitation. In addition, future research may expand the study population and perform studies in industry with the participation of experienced analysts.

## References

- Agarwal, R. and Tanniru, M.R. (1990). Knowledge acquisition using structured interviewing: An empirical investigation. *Journal of Management Information Systems*, 7, 123-140.
- Berry, D.M. (1995). The importance of ignorance in Requirements Engineering. *Journal of Systems and Software*, 28(2), 179-184.
- Berry, D.M. (2002a). The Importance of Ignorance in Requirements Engineering: An Earlier Sighting and a Revisitation. *Journal of Systems and Software*, 60, 83-85.
- Berry, D.M. (2002b). Formal methods: the very idea, some thoughts about why they work when they work. *Science of Computer Programming*, 42, 11-27.
- Bostrom, R.P. (1984). Development of Computer-Based Information Systems: A Communication Perspective. *Computer Personnel*, 9 (4), 17-25.
- Browne, G.J. and Rogich, M.B. (2001). An empirical investigation of user requirements elicitation: comparing the effectiveness of prompting techniques. *Journal of Management Information Systems*, 17, 223-249.
- Buxton, J.N. and Randell, B. (1969). *Software Engineering Techniques: Report on a Conference*. NATO Scientific Affairs Division, Rome, IT.
- Coughlan, J and Macredie, R.D. (2002). Effective Communication in Requirements Elicitation: A Comparison of Methodologies. *Requirements Engineering*, 7(2), 47-60.
- Davis, G.B. (1982). Strategies for information requirements determination. *IBM Systems Journal*, 21, 4-30.
- Davis, J., Fusfeld, A., Scriven, E. and Tritle, G. (2001). Determining a project's probability of success. *Research-Technology Management*, 44 (3), 51-62.
- Friedrich, W.R. and Van Der Poll, J.A. (2007). Towards a Methodology to Elicit Tacit Domain Knowledge from Users. *Interdisciplinary Journal of Information, Knowledge, and Management*, 2, 179-193.
- Hickey, A.M. and Davis, A.M. (2004). A Unified Model of Requirements Elicitation. *Journal of Management Information Systems*, 20, 65-84.
- Hofmann, H. and Lehner, F. (2001). Requirements engineering as a success factor in software projects. *IEEE Software*, 18 (4), 58-66.
- Kassel, N. and Malloy, B.A. (2003). An Approach to Automate Requirements Elicitation and Specification. *Proceedings of the 7<sup>th</sup> IASTED International Conference on Software Engineering and Applications*, Marina del Rey, CA, USA, 544-549.
- Nuseibeh, B. and Easterbrook, S. (2000). *Requirements Engineering: A Roadmap. The future of software engineering*, ACM Press, 37-46.
- Pitts, M.G. and Browne, G.J. (2007). Improving Requirements Elicitation: An Empirical Investigation of Procedural Prompts. *Information Systems Journal*, 17(1), 89-110.
- Strauss, A. and Corbin, J. (1990). *Basics of Qualitative Research; Grounded Theory Procedures and Techniques*. Newbury Park, Sage.
- Van Buren, J. and Cook, D. (1998). Experiences in the Adoption of Requirements Engineering Technologies, CROSSTALK. *The Journal of Defense Software Engineering*, 11 (12), 3-10.
- Watson, H.J. and Frolick, M.N. (1993). Determining information requirements for an EIS. *MIS Quarterly*, 17, 255-269.
- Wiley, J. (1998). Expertise as mental set: The effects of domain knowledge in creative problem solving. *Memory & Cognition*, 26, 716-730.