Teaching Requirements Elicitation Interviews: Empirical Study of Learning from Mistakes

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Abstract

[Context] Interviews are the most widely used elicitation technique in requirements engineering (RE). However, conducting a requirements elicitation interview is challenging. The mistakes made in design or conduct of the interviews can create problems in the later stages of requirements analysis. Empirical evidence about effective pedagogical approaches for training novices on conducting requirements elicitation interviews is scarce.
[Objectives] In this paper we present a novel pedagogical approach for training student analysts in the art of elicitation interviews. Our study is conducted in two parts: first, we perform an observational study of interviews performed by novices, and we present a classification of the most common mistakes made; second, we utilise this list of mistakes and monitor the students' progress in three set of interviews to discover the individual areas for improvement.
[Research Method] We conducted an empirical study involving role-playing and authentic assessment in two semesters on two different cohorts of students. In the first semester, we had 110 students, teamed up in 28 groups, to conduct three interviews with stakeholders. We qualitatively analysed the data to identify and classify the mistakes made from their first interview only. In the second semester, we had 138 students in 34 groups and we monitored and analysed their progress in all three interviews by utilising the list of mistakes from the first study.
[Results] First, we identified 34 unique mistakes classified into 7 high-level themes, namely question formulation, question omission, interview order, communication skills, analyst behaviour, customer interaction, teamwork and planning. In the second study, we discovered that the students struggled mostly in the areas of question formulation, question omission and interview order, and did not manage to improve their skills throughout the three interviews.
[Conclusions/contribution] Our study presents a novel and repeatable pedagogical design and our findings extend the body of knowledge aimed at RE education and training by providing an empirically grounded categorisation of mistakes made by novices. We offer an analysis of the main pain points in which instructors should pay more attention during their design and training.

Keywords: Requirements Engineering Education and Training, Requirements Elicitation, Interviews

1. Introduction

Interview techniques have been used in a variety of fields, such as journalism, psychology, criminal justice and anthropology, to learn about the conscious or tacit ideas, concepts and knowledge that people carry inside their minds on any phenomenon [1]. An interview is a communicative event in which an interviewer asks questions to reach to the reality of a phenomenon conceived inside the mind of the interviewee.

Requirements elicitation aims at learning and discovering the needs of the stakeholders of the system [2] and still remains a challenging and problematic area in requirements engineering (RE) [3]. Requirements elicitation is challenging as this phase of RE explores the boundaries of knowledge, the people who possess this knowledge and how to acquire (and organise) that knowledge [3]. The information gathered during requirements elicitation needs to be correct, complete and unambiguous. In RE, interviews have been the most widely used elicitation technique, and are considered among the most effective in terms of information acquisition [4, 5].

In RE Education and Training (REET), the effectiveness of analysts in conducting requirements elicitation interviews highly depends on having experienced and actively participated in real interviews [6]. However, empirical evidence has shown that the methodological soundness and correct conduct of interviews is also important [4]. Therefore, in principle, both novice and experienced analysts can elicit high-quality requirements when the interview is well-planned. Mistakes made during design and execution of the interview tasks can impact the resulting software and system requirements [7].

An important part of training students on how to plan and perform elicitation interviews is to teach them how to prepare for the interview (e.g. by composing the right questions, making rapport with the interviewee, etc.). Another essential element of training is to bring awareness about the mistakes often made by novice analysts during these interviews. Students can learn from their mistakes based on the feedback provided by the trainers and improve their skills by practice. Feedback-based pedagogical approaches have been applied effectively in various other disciplines for teaching [8, 9].

Research has demonstrated the effectiveness of role-playing pedagogical approaches in REET by providing authentic assessment for the students [10, 11]. The educational approaches designed with authentic assessment require the educator to simulate the real-world environment aimed at student learning by practice [12]. Mistakes, if observed explicitly during practice (even in simulation), can become a learning resource for students in the form of feedback. Furthermore, a comprehensive catalogue of mistakes made during elicitation interviews can be utilized in REET courses to help students better prepare for their role-playing activities.

In this paper, we present the results from our empirical research comprising of two studies. The first study aimed to identify the mistakes made by student analysts during their role-playing in their first requirements elicitation interviews. The study resulted in a list of 34 mistakes made by the students, grouped into 7 high-level themes.

In the second study, the list of documented mistakes from the first study was used to evaluate the frequency of the mistakes across three subsequent interviews made by the students. The goal of this study was to better understand whether the learning approach followed is effective for improving the

skills of the students. The results of this second study showed that overall students did not improve throughout the different interview stages, and tended to repeat the some mistakes

The overall performance of students in both studies indicates that they made more mistakes in domain-related aspects in comparison to the social aspects of interviews.

This paper is the extension of our previous work presented at the International Requirements Engineering Conference (RE 2018) in Banff, Canada [13]. Our research builds upon the Requirements Engineering Education and Training body of knowledge with the following contributions:

- We have identified a list of 34 unique mistakes made in elicitation interviews by novices that are classified into 7 high level themes. We provide contextual information and indicative recommendations, to assist the educationists and trainers for teaching the art of elicitation interviews.
- In the second study we demonstrate that the list of mistakes can be used as an effective instrument for analysing and assessing the progress of students in learning the elicitation interview process and identifying their weaknesses in specific areas.
- Our rigorous research design is a novel combination of several well-known pedagogical approaches that we used to conduct this observational study, such as role-playing, corrective feedback learning, and authentic assessment. This pedagogical design has been described in sufficient details to make it repeatable for future REET research.

The paper is organized as follows: section 2 summarizes the background and related research work available on interviews. Section 3 highlights our motivation. Section 4 discusses our pedagogical design of the subject and section 5 gives details of the steps of research design and results. Section 6 discusses the implications of the research. Section 7 states the threat to validity and section 8 provides conclusion and future works.

2. Background and Related work

Requirements elicitation interviews are recognized as one of the most effective and used techniques to elicit requirements [4]. Nevertheless, only a small part of the effort of RE community has been focused on studying the art of interviews in its depth as a knowledge acquisition tool and, more in general, elicitation technique [14]. There is little research focus on providing guidance to RE educators regarding effective pedagogical approaches on teaching students how to conduct elicitation interviews.

2.1 Factors Affecting Interview Success

Most of the existing work on interviews focuses on identifying the variables that affect the success of an interview. In particular, the influence of domain knowledge [15-18], and cognitive strategies [19] were evaluated, as well as the combination of other individual factors, such as the expressive ability of the customer, and the absorptive capacity of the analyst. In the study of Distanont et al. [20], the variables that affect interviews have been categorized in three main classes: human-oriented, process-oriented, and context-oriented factors. For some of the analysed factors, both positive impact and a negative impact have been identified. Two examples of these factors are: 1) domain knowledge [16], which, on one side, can help to prepare better questions and use a more appropriate language, and, on the other, might convince the analyst that she knows the answers better than the customer; 2)

ambiguity [21], which is usually perceived as an obstacle to knowledge transfer, but, once identified in interviews, can lead to disclose tacit knowledge.

Another relevant factor for the success of interviews is the adequacy of communication. In this context, through a theoretical study, Coughlan and Macredie [22] identified articulation, misunderstanding, and conflict as the general classes of problems that hamper communication during requirements elicitation. Through empirical studies, (e.g., by Agarwal and Tanniru [23] and Browne and Rogich [24]), possible structures and models for the communication during interviews have been identified with the goal of improving the effectiveness in collecting requirements. Other works went a step forward and looked at how to improve communication in interviews through precise guidelines. For example, Pitts and Browne [7] showed that using procedural prompts that stimulate cognition, instead of interrogatories ones, lead to more successful interviews. Shuraida and Barki [25] showed that analysts who encourage the use of concrete examples are more likely to produce satisfactory requirements. From a practitioner's perspective, Portugal's work [26] provides a large set of guidelines, based on the author's experience, to conduct a successful interview.

2.2 Teaching interviews

None of the works mentioned in previous section, however, provides a set of guidelines of what to do and not to do in a requirements elicitation interview, or a comprehensive analysis of the most common mistakes of analysts, especially novices, who lack experience and the needed skills, which, together with communication talent, are among the factors that mostly affect the quality of interviews [2, 16]. An initial work in this direction was published by Donati et al. [6], who identified and categorized nine mistakes that student analysts commonly make in interviews. The mistakes were derived from a thorough analysis of a set of student-performed interviews.

Besides this initial work, the literature does not offer any tool to effectively teach how to perform a successful interview, which should be one of the primary objectives of requirements engineering courses [11]. Unfortunately, because of the lack of tools and the lack of time this objective is often neglected. Indeed, computer science related degrees either offer only a course on RE, which should include all the different activities related to the discipline or, even worse, offer only a software engineering course in which at best, RE is relegated to a couple of lectures.

Given the lack of preparation of many analysts and the importance of this activity, many online trainings and courses have been created to help analysts to conduct more effective interviews. Lynda.com [27] offers a one and a half hour subscription training composed of 5 modules in which the main aspects of an interview are covered. The course also contains examples and challenges. Interviews are also taught as first-class citizen in subscription specialization online courses (e.g., [28, 29]) in which video-scenarios are provided to better contextualize the taught concepts. A training for interviews and workshops for IT projects is provided in a book form by Hathaway [30]; this training includes initial definitions, motivations, and some guidelines. Also, a short variety of YouTube videos are provided to identify the main characteristics of requirements elicitation interviews and the most needed skills to succeed in them. However, none of these trainings and videos deepens in the analysis of the communication problems, systematically analyses the most recurrent mistakes, and proposes solutions for them. Most of these videos are mainly based on the experiences of the training developers.

2.3 Interviews in other Disciplines

Besides RE, interviews are important tools also in other disciplines, such as journalism, psychology, qualitative research methods, and criminal justice. In these fields, the analysis of interviews and the tools provided to teach them are in a much more mature state and have been developed through thorough research and deep analysis and experience. A large body of literature is available on how to conduct interviews in these fields and which common mistakes to avoid. In journalism, for examples, books such as [31], provide a practical, well-structured, easy-reference guide for journalists at any entry level: students, trainees and novices. It covers the analysis of interviewing techniques, the types of interviewees and how to read body-language. Since interviewing methods can differ depending on the goal of the interview, there are books specific to different products, such as the one of Martin [32], in which the author discusses interviewing methods for actuality documentaries, deeply analysing how they need to be run and prepared, and which situations to avoid. The field offers also books by the most expert journalists, such as for example Grobel [33], in which the readers can learn from the authors' memorable experiences and their analysis. It has to be noticed that journalism is an independent academic discipline with an autonomous degree [34] and this explains the abundance of material that targets young interviewers.

In social sciences, such as psychology, interviews are used as a double instrument, to collect qualitative data for research or to interact with patients. People interested in using them to collect data for research can refer to an extensive literature, which comprises both introductory works that define the different types of interviews and data collection methods (e.g., [35, 36]), more practical works that provides tips for running interviews (e.g., [37-39]), and books that generally contain both (e.g., [40, 41]). The tips-focused papers target either students [37] or inexperienced analysts [38, 39]. Among the other tips, Jacob and Furgerson [37] encourage students to go into an interview with a script that covers it from the beginning to the end. The script should consist of the reasoning behind the interview, explanations as to how the interview should progress, and a little introduction to build rapport between the interviewee and the analyst. This does not necessarily mean that the analyst cannot deviate from the script. In fact, it is encouraged that the student be willing to make 'on the spot' revisions to the interview protocol. The script should be used to guide the interview process, so details that need to be questioned or mentioned do not get missed in the conversation between the interviewer and the interviewee. This is in line with Diley's suggestion of working on an accurate protocol before walking in an interview [39].

On the practitioners' perspective, psychology, being taught as a university major as journalism, includes precise guidelines and provides tools for students and young practitioners to correctly run interviews. A comprehensive example of these guidelines is provided in [42], which is a manual on interviewing mental health patients based on objective research and best-practice principles. Other works in the field focus on giving recommendations, such as focusing on positive aspects while interviewing [43], or analysing strategies depending on the considered mental disease [44]. Interview techniques and skills are deeply studied also in criminal justice, where interviews are distinguished from interrogations, legal issues are faced, and different criteria are applied [45]. Besides traditional tools, trainings [46] are also available to cover the theory behind interviews and to practice through role-playing exercises.

The professionalism and quality of the results in conducting interviews in the above-mentioned fields suggest the need of producing similar guidelines, based on research, also in requirements engineering.

Unfortunately, given the differences in goals and in the relationships with the interviewees with respect to these disciplines, new studies to deduce field-related guidelines are needed.

3. Motivation

The authors of this paper belong to five different academic institutions in Europe, United States and Australia. Our combined experiences of teaching RE courses in the last 2 decades both at undergraduate and postgraduate level has provided a rich tapestry of issues and challenges for REET. We have experimented with utilizing several pedagogical approaches to enhance and improve the learning outcomes.

Our motivation for this study comes from many years of observing how university students struggle to learn effective requirements elicitation interviewing techniques. Over the years, we have attempted to inform students on an *ad hoc* basis about possible mistakes that one can make in interviews. To do this task more efficiently, we have recognized a need to have an empirically validated list of possible mistakes and the corresponding examples to provide to students in a more formal manner. Therefore, one of the main aims of this observational study is to develop such a list and related examples to assist students in learning the skills of effective elicitation interviews. Furthermore, we believe that the list of mistakes is a very effective instrument for educators and trainers for monitoring students' progress when used in consecutive interviews.

Historically, our REET research began in 2003, when the second author introduced the authentic assessment environment through role-playing activity in stakeholder interviews [11]. Later, the Requirements Engineering Education and Training (REET) workshop was initiated in conjunction with the International RE conference in 2007 in order to generate awareness around the contextual pedagogical needs of RE students [12]. More recently, our first study [13] was inspired by our collective teaching experiences and partly triggered by a similar study by Donati et al. in REFSQ 2017 [6]. However, our study differs fundamentally from the work of Donati et al. in a number of ways that we describe below. Many of these differences are informed by our previous experiences of teaching RE classes using role playing, as well as several self-identified limitations and some of the deficiencies we observed in [6]. Our first study [13] differs from [6] in the following ways:

- **Participants** – In our study, we had 110 first-year Master of IT students engaged in elicitation interviews as part of their first assessment task in their RE class. Donati et al. engaged 38 undergraduate students in their 3rd and 4th year in their "User Centred Design" course.
- **Role-playing** – In our study, the role of customer was played by an experienced RE researcher and instructor who was also the tutor for this course; while in their case, half of the class played the role of customer and the other half the role of analyst. The decision for not using students to play customer role was based on the results of previous research [10, 11]. So, in our study, we had a single customer who was able to do consistent delivery of responses to questions in the interviews.
- **Case studies –** In the study, by Donati et al., the customer participants were required to think about a "novel computer intensive system" for interviews, while our participants were divided into two and each half was given a different case study prepared by the instructor in the form of a one-page project brief to commence.
- **Preparation –** Donati et al. prepared the analysts by a two-hour lecture on requirements elicitation interviews. Our participants were told to do the short course on requirements

elicitation interviews on Lynda.com. They also attended an introductory lecture on requirements elicitation and more specifically on how to plan and prepare for interviews. In this lecture and the follow up tutorial, students were exposed to a number of common mistakes students make in their interview that included the list from Donati et al. Finally, we designed and created a few video recordings of good and bad interviews that were made available to students to help them in preparing for interviews.

- **Conduct of interviews** – Our interviews were semi-structured while theirs were unstructured. Their interviews were one on one, whereas our activity was designed for collaborative learning, hence a team of 3 or 4 group conducted the interview with one customer.
- **Interview output** – There was no written output required from the analysts after the interviews in Donati et al.'s study. In our study all the groups were asked to submit minutes of their interview for assessment.

4. Pedagogical Design

Software engineering (SE) discipline is required to produce industry-ready graduates. Therefore, curricula need to prepare students not only with current technical knowledge but also with self-learning and soft skills. Software engineering educationists have been employing combinations of *'learning theories'* that have their roots in educational philosophies, most of which fall under the constructivist paradigm of learning [47]. Some of the *'learning theories'* most widely used by software engineering educators in their curricula design are 'Learning by Doing' [48], 'Situated Learning' [49], 'Discovery Learning' [50], 'Learning through Failure' [51], and 'Learning through Reflection' [52]. These learning theories provide the foundations of 'problem-based', 'project-based', 'collaborative' and 'authentic' learning. SE educators have been using these theories in designing curricula for more than two decades now e.g. 'The Real World Lab' [53], 'The Software Factory' [54] and 'Software Engineering Studio'[55].

Before the students reach their capstone project stage where they can be given a chance to face a real-world environment, they need to develop problem solving and social skills besides technical knowledge. Therefore, most of the SE and RE courses are designed based on problem-based learning and collaborative learning paradigms. Authentic assessment in collaborative learning paradigm provides students with the simulation of real-life challenges in which they have to focus on problem solving skills based on their previously gained knowledge and the management practices [56, 57]. In authentic assessment, students demonstrate their competencies of knowledge, skills and attitudes in a professional context [58]. The *'context'* is the base planned by the educators to provide the real-world setting for learning outcomes and aims for the industry-readiness of the students [56]. The real challenge that SE and RE educators face is that of bringing the right balance of *'realism'* and the control of the classroom environment for the students in their curricula and assessments [59].

In Figure 1, we present the overall pedagogical design of the requirements elicitation activities and the two assessments tasks that are the outputs from the interviews. All groups are required to perform three interviews about the same product. In each interview, a tutor plays a different customer role, namely the project sponsor in the first interview, and a technical expert or a domain expert in the second and third interview. After each interview, students are required to produce minutes of meetings, and the tutor gives feedback on them before the following interview. Furthermore, the students also receive collective feedback on the most common problems observed by the tutor. The

output of the overall activity, used for assessment, is a use case document required after second interview, and a SRS document for the system required after third and final interview.

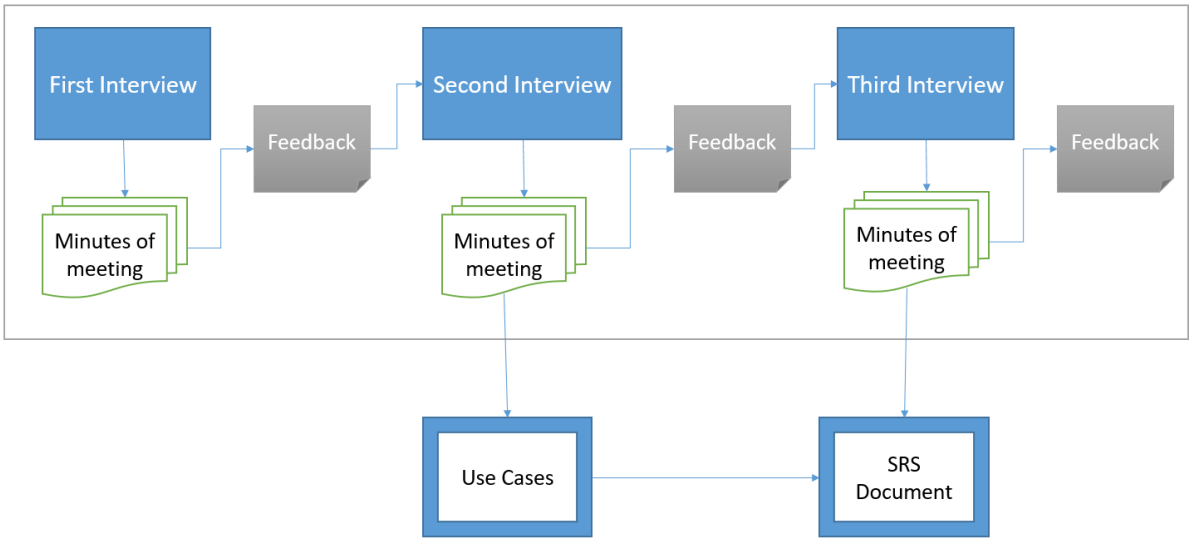

Fig. 1. Pedagogical design of interview activity

We use a combination of educational pedagogies in our study for the complex task of elicitation interviews in order to not only give the students an authentic experience of dealing with a customer, but also provide them the right guidance based on their mistakes and an opportunity to improve upon their mistakes. The pedagogical design outlined in Figure 1 is based on the guidelines of the following educational pedagogies:

- **Corrective Feedback Learning**

  This paradigm advocates for using failures, mistakes or bad decisions as learning opportunities to improve in the future. In our study, we repeated the interview tasks three times over a period of three weeks, to give students time to reflect and prepare for the next round (Figure 1).

- **Role-Playing Activity**

  In role-playing activities, we provide an environment for the student for rehearsing a real-world problem-solving scenario for practicing certain skills. The students were to interview the business owners in a first interview and then other stakeholders in the second and third interviews (as they identified in their first interview).

- **Authentic Assessment**

  Using the role-playing activity and case study-based learning we replicate real-world challenges and standards of performance that experts or professionals typically face in the field. Some of the guidance were taken from the Dawson's [59] 20 tricks for creating authentic environment within classrooms, i.e. by providing ambiguous project brief, challenges of dealing with customers, etc.

- **Collaborative Learning**

  Authenticity requires the students to work on a problem within a social context and dealing with other members of the group. In our activity, we involved groups of students to work together on their case study, and prepare and conduct the interviews. This would not only challenge their problem-solving skills but also their social skills.

5. Research Design and Results

The work presented in this paper aims to studying mistakes made by student analysts in requirements elicitation interviews. To this end, we setup an exploratory study aimed to answer the following research questions:

- RQ1: *What are the categories of mistakes that student analysts make during their first interview?* This question aims to identifying general classes of mistakes showing occurrences of these mistakes in practice.
- RQ2: *How frequent are the categories of mistakes across subsequent interviews performed by student analysts?* This question aims to give a numerical estimate for the occurrence of the different mistakes, and to understand whether the students are able to improve their skills from the first to the last interview. The goal is to better understand whether the learning approach followed is effective for improving the skills of the students.

To answer RQ1, we perform our first study (**Study 1**), in which the pedagogical design described in Section 4 is applied. In this study, we identify the most common mistake categories by means of a set of reviews made by interview experts and a thematic analysis of the reviews. This study focuses on only the first interview performed by the students.

To answer RQ2 we perform a second study (**Study 2**), with the same pedagogical design, but a different cohort of students. Given the mistakes identified from Study 1, we define a questionnaire to allow interview experts to assess the occurrence of the identified mistakes in the interviews. To enable the analysis of the evolution of mistakes across interviews, we extend our analysis to all three interviews. The numerical results of the questionnaire are used to assess the frequency of the mistakes across interviews.

In the following sections, we describe the two studies in terms of data collection, analysis and results.

5.1 Study 1

5.1.1 Study Context

The study was conducted in a university setting with master-level students of Information Technology enrolled in *"Enterprise Business Requirements"* class. The first assessment task was for students to develop a complete software requirements specification (SRS) for a customer, based on a one-page project brief provided by the instructor (second author). The 110 students were grouped into 28 teams comprising of 3 to 4 members. Each team was instructed to conduct three interviews over three weeks with the stakeholders, to elicit the requirements. After the completion of each interview, students were required to submit the minutes of their meeting with the customer on a specially-designed template within 2 days after the interview to capture what they had understood. It should be noted that the observations and analysis are entirely based only on the first interview. The first part of the deliverable was a set of use cases developed from the information elicited in the first two interviews. The final part of the assessment was a complete SRS using the IEEE standard template. The requirements elicitation interviews took place after students attended lectures on requirements elicitation and relevant techniques, attended a workshop for practicing interviews with customers. Students were also asked to watch the video courses on Lynda.com about *"Requirements Elicitation for Business Analysts:*

Interviews" [27] and do all the exercises given. Two case studies[1] were designed by the instructor and the class was divided into two, one half did the first case study while the other half tackled the second case study. Students were provided with the project brief of the case studies, for which they had to prepare an interview. The one page project brief described the current business process and the need for a new system. All groups were allocated 15 minutes for each of the three interviews with the customer of the case study they were assigned. A corrective feedback learning approach was adopted for the whole task. The aim of observing mistakes was not to assess the students for the quality of the interviews but to provide them feedback for the next round so they can improve their interview skills. The interviews were conducted as a role-playing activity with authentic assessment pedagogical setting [10, 11], in which we simulated a real-world environment for the students to perform interviews with a customer. The task was collaborative in nature. The students were expected to plan for the interview as a group while various tasks were divided among members, such as preparing questions, asking questions, taking notes, audio recording interviews, and preparing minutes of meetings.

5.1.2 Data Collection and Analysis

The research is exploratory and interpretive in nature and we used a qualitative approach to data collection and analysis. The second author was the instructor and coordinator of the course who designed the curriculum and delivered all the lectures. We had multiple Requirements Analysts; RAs (28 groups of students), a Customer; C (role played by the first author for all the groups, an academic and experienced RE researcher), an Observer; O (third author, experienced RE researcher), and two Reviewers; R1 (lecturer from another university; the fourth author), and R2 (a business analysts; the fifth author). The data was collected in three ways: audio recordings of the interviews, about 7 hours; the observation notes of the researcher (O), 4451 words; think aloud of the customer after every interview (C) in conversation with O (who took notes), 1635 words. The audio recordings were reviewed by two researchers (R1, R2), and qualitatively analysed independently for the mistakes the student analysts made in each interview, producing 4748 (R1) and 3546 words (R2). The use of "think aloud" was oriented to identify the mistakes perceived by the customer's role during the interview, which may be different, also in terms of perceived relevance (e.g., rapport with the customer), from those that could be observed externally. Overall, a total of 14,380 words (about 32 pages) of data was produced for further analysis. We had additional 28 documents of minutes of meetings submitted by all the groups after the interview. Figure 2 presents the overall method of data collection and analysis.

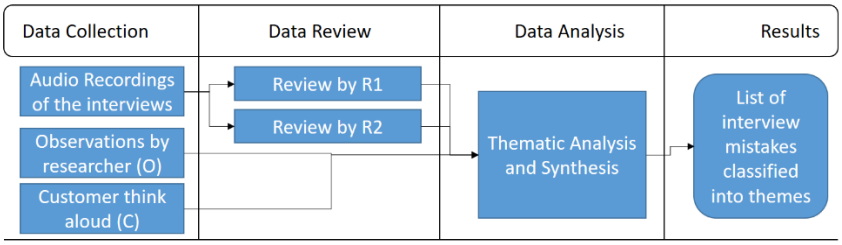

Fig. 2. Steps of data collection and analysis

Two of the researchers (first and second authors), carried out the thematic analysis of all the data and synthesized the list of mistakes into classified themes. The four sources of data (two reviews, observation notes, and customer think aloud) were first stratified for individual groups for further

[1] Case Study 1: https://drive.google.com/file/d/1DLXjLUnqISrq2XlSmuZYf4GlS9FGhuZP/view?usp=sharing
Case Study 2: https://drive.google.com/file/d/1EMOhQOw4GCFfQoT7nCYgOlSN4sLNain-/view?usp=sharing

analysis. Some mistakes were observed in all four sources of data, whereas there were cases of additional new and unique mistakes identified from the two reviews based on audio recordings. Our findings concur with [60, 61] that review of interview audio recordings provides more insights and reduces the bias of observations by triangulating the data from neutral perspective, as the reviewers are not being present at the time of the interview. All the recorded mistakes were coded to identify the unique mistakes for each group and later analysed for their frequency of occurrence in all groups. The mistakes were further classified into higher-level themes corresponding to the particular aspect of the interview. The final classified list of mistakes was peer-reviewed by one researcher (third author). There were instances of disagreements related to the naming of themes and grouping, and they were resolved in discussions. After synthesizing and categorizing the list of mistakes, we reviewed the minutes of meetings submitted by all the groups. The aim was to investigate any plausible relationships between the types of mistake made during interviews and the extent of students' understanding based on what was recorded in the minutes. For this purpose, we had to go back and listen to some of the audio recordings again for further analysis.

5.1.3 Results from Study 1

In this section, we present the results from our analysis and discuss the findings. We identified 34 unique mistakes classified into 7 higher-level categories of mistakes:

- Question Formulation
- Question Omission
- Order of Interview Questions
- Communication Skills
- Analyst Behaviour
- Customer Interaction
- Teamwork and Planning

Figure 3 shows the list of classified mistakes along with their frequency of occurrence observed in 28 groups. The most frequently observed mistakes are (1) asking vague questions, (2) incorrectly ending of the interview and (3) not building rapport with the customer. We discuss these categories in the following by providing examples from our qualitative data. Some of the examples may demonstrate more than one type of mistakes.

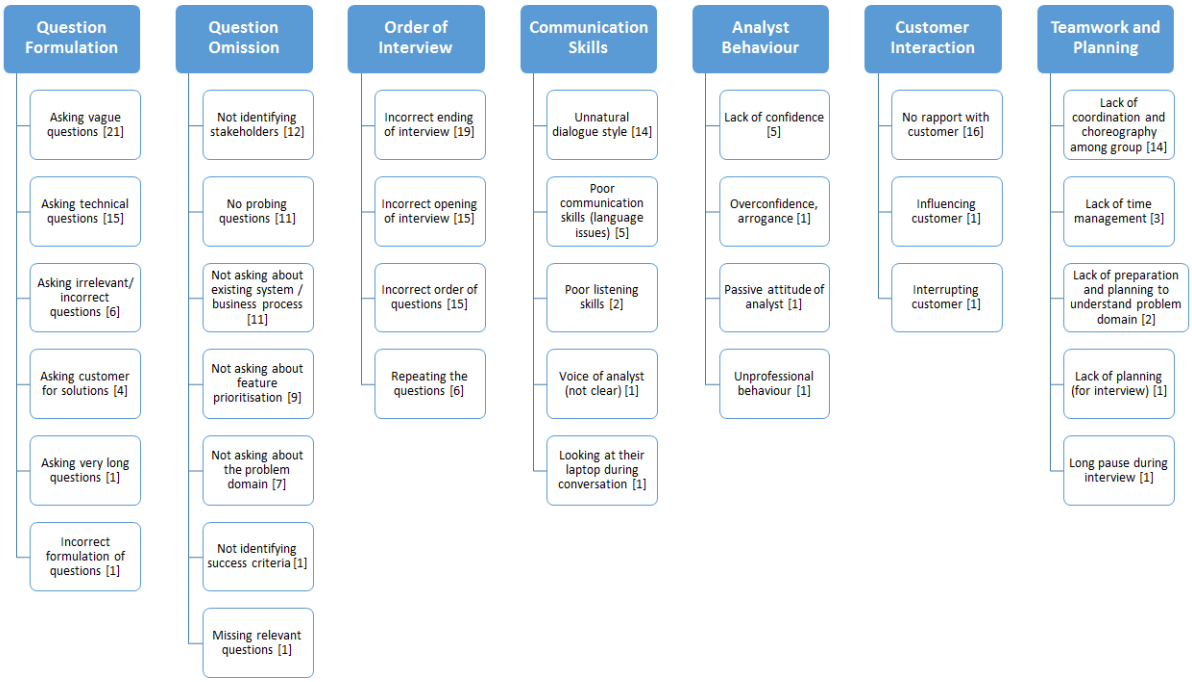

Fig. 3. Classification and frequency of interview mistakes

Question Formulation

This category of mistakes refers to the problems and issues about the questions that student analysts asked the customer during their interviews. In a well-planned interview, the analysts have time in advance to prepare for writing down clear and unambiguous questions [6]. A response to the question depends on how the question is formulated. Vague, incorrect or unclear questions are rarely going to elicit correct responses from the customer.

The major mistakes observed in this category are: (1) asking vague questions, (2) asking technical questions, (3) asking irrelevant or incorrect questions, and (4) asking customer for solutions. We now give examples of the excerpts from the data used in the study. Some of these excerpts may also include the exact questions asked or statements made by the students in the interviews.

Asking vague questions

'Asking vague questions' was the most frequent mistake made by student analysts and was observed in 21 instances out of 28 interviews. We define vague questions in this context as the type of questions that may yield multiple interpretations, or cases where no reasonable meaning can be inferred from the questions asked. The ambiguities that can result from the response of the customer to a vague question can create further issues in later stages [62]. We provide some of the indicative examples of 'vagueness' in interview questions from the reviews and observations.

The reviewers observed that the student analyst asked vague questions on success, failure and risks of the project.

- *"The [analyst] asks about measuring success, the question is always vague …, and [the analyst] does not propose a way to measure success. They ask about risks, but the [customer] doesn't know how to estimate"*
- *"Some questions are not understood by the customer because they are too vague or posed at the wrong time … [they] are out of context at the end of the interview when goals, success criteria and motivations have already been discussed"*

The following were the examples of the questions asked by students that were pointed out by the reviewers to be "too vague" for the customer, and were asked out of context, therefore the customer could not provide appropriate response:

- *"What is the impact of the project to your business?"*
- *"Can you indicate the major constraints of the project?"*
- *"Do you want some specific features on the website?"*
- *"What are your expectations?"*

These types of questions are hardly going to trigger the reasoning or stimulate follow-up discussion with the customer [24] and they indicate that the analyst is inexperienced in the art of question formulation [63].

Asking technical questions

Our data was collected from the first interview with a customer, who is in fact the project sponsor and business owner. The students were expected to have researched the customers' business context and prepare appropriate questions. Asking *'technical questions'* from the customer so early may not get an adequate response because it cannot be assumed that the business owner/project sponsor has detailed technical knowledge. Asking technical questions may also intimidate the customer and can lead to bad rapport. Following are the excerpts of the reviews on asking technical questions:

- *"Often the interviewer assumes that the stakeholder has a technical background: questions on "secure" or the use of Oracle. [The analyst] never checks on the common vocabulary with the interviewee and is not concerned about some possible previously happened misunderstanding even when the [customer] tells [the analyst] that [the customer] does not have a technical background."*
- *"part of the interview is devoted to purely technical aspects that perhaps may be left to a second step [next interview]"*

The reviewers provided examples in some cases about the questions that students asked:

- *"The analyst uses often technical language: 'How do you map the business goals to the system goals?', or again 'What is the minimum viable product'(!), the customer can't understand and asks for clarifications,"*
- *" 'If the system fails do you have a backup?'; the customer doesn't understand this question because is not the right person to be questioned about technical features."*

Asking irrelevant or incorrect questions

This category refers to asking questions that are not relevant for the development of the system, or are inappropriate for the profile of the customer. Asking 'irrelevant or incorrect questions' will not only waste the time during interview session but also will add to the irrelevant data elicited during interview that might contribute to creating erroneous or redundant requirements. Asking these types of questions has been recognized as one of fundamental mistakes in requirements elicitations [64].

As the reviewer observed in one example case: *"They asked an incorrect question, concerning the customers having access to the inventory"*. The question was asked even though the customer had explicitly mentioned the role of a person who deals with the inventory. Another example observed by reviewer was the way the student analyst explained the security of the system – *"The security question scares the customer"* – and persuaded to express concerns on the security that was not required.

The other less frequent mistakes observed in this category were the students asked customer for *"solutions"*, or asked a *"very long question"* that the customer has to ask for repeating or rephrase multiple times.

Question Omission

This category of mistakes refers to omitted questions that were expected to be asked by the student in the first interview. In this category the most frequent mistakes observed are when student analysts (1) did not ask to identify relevant stakeholders, (2) did not ask follow-up or probing questions, (3) did not inquire about existing system or business process, (4) did not ask the customer to prioritize the features and (5) did not ask about the problem domain. Missing these types of questions could potentially lead to missing requirements in later stages.

Below are examples of excerpts from comments identified in our data:

- *"[analyst] did not ask about stakeholders, they did not look very well planned."*
- *"they [analysts] did not ask probing questions …, like they thought that the maximum information that could be elicited was reached already."*
- *"They [analysts] did not ask about the problem or the existing system/process. Overall, they have details, but not the [bigger] picture, while this should be made explicit in the interview. "*
- *"They [analysts] did not prioritize the features that were required by the customers."*
- *"They [analysts] could not provide examples ... when [the customer] asks to elaborate, they couldn't. They appear not having thought about the domain … questions are all generic, domain independent."*

This exercise was the first stakeholder interview for the student analysts, and they were expected to find out the relevant people in the business and decide who they would interview next. Stakeholder identification is one of the important activity in requirements elicitation [65]. 12 out of 28 groups did not identify relevant stakeholders. A possible explanation for this mistake, as pointed out by [65], is that analysts mostly view stakeholder identification as a 'self-evident task', or they attempt to have fewer conflict of interests arising from the point of view of different stakeholders.

Not asking probing and follow-up questions during the interview would fail the purpose of face-to-face communication, as interviews are reported to help analysts resolve the ambiguity that emerges during the interview [21], and to push the customer to express the tacit knowledge about the existing business process or system [66].

Order of Interview Questions

This theme refers to the mistakes about the overall order in which the questions were asked, i.e. the start of the interview, the order in which the questions are asked, and the ending of the interview. The order in which the questions are asked creates a flow of conversation that should lead in a logical way for customers to explain the project vision, and explain why they need a system within the existing business process. It was frequently observed that the student analysts did not make an attempt to have a good start and/or end to the interview but also asked the questions in incorrect logical order throughout the interview.

The excerpts from the data showed multiple examples in which the students did not try to build rapport with the customer at the outset, they asked questions about solutions before understanding the problem, and ended the interview abruptly without any final summary of the collected information.

- *"They [analysts] do not introduce each other and asked suddenly 'what is the feature of success?'. This question should be asked later."*

- *"the interview begins with a series of direct questions even if we would expect a general description of the project."*
- *"the dialogue ends abruptly and a final summary is missing"*
- *"The questions are also in the wrong order, for example the very first one is 'What are the project's success criteria for you?' and only after he [analyst] asks 'What do you want to get?' and after that he asks 'What are the goals? "*

It is necessary for the analysts to form a questioning strategy and include prompts based on the context of their interview, this can help in eliciting particular requirements as well as overcoming the challenge of customer-analyst interaction [24]. Prompting strategies can provide an opportunity for the analyst and user to re-evaluate acquired information. This should result in a more complete and more accurate set of requirements [7].

The strategy recommended to the student in this exercise was to: start the interview by building rapport with the customer, understand the existing business process, understand the problems faced by the customers in current process in order to reason on the need for a new system. Towards the end of the interview, summarize the findings to the customer to confirm the understanding. 19 out of 28 groups did not summarize the findings, and 15 groups did not open the interview correctly and asked questions in the wrong order. Summarizing the findings of the interview is a best practice for overcoming the misinterpretations during the interview [7] and overcoming any cognitive limitations during customer and analyst communication [24].

Communication Skills

Interviews are a communicative-intensive activity in which the analyst has to be involved in a face-to-face communication with people from diverse backgrounds, skills and knowledge levels [22]. In order to create a shared understanding with the customer during the interview, the communication skills of analysts are crucial. The analyst has to work on extra effort to remove the semantic gap and push the customer to the boundaries of their tacit knowledge. Effective communication has always been quite challenging for the analysts who are dealing with customers, and is one of the most frequently recurring issues in requirements elicitation [67].

The data collected in our study in many cases pointed out that the dialogue with the customer was not considered as a natural conversation but more of a rehearsed sequence of asking interrogation like questions. This can make the customer uneasy. The use of common vocabulary during interview is also very important and the analysts should plan and prepare so that they will not use the words that might confuse the customer. The following examples from review excerpts demonstrate the observation made about the poor communication skills of student analysts:

- *"The dialogue is confusing and customer doesn't understand the questions, mostly due to poor linguistic skills (of the analysts)."*
- *"the fact that the [analysts] are clearly following a series of good practices they read on a book make the structure of the interview rather scholastic and the dialogue unconvincing in some points. I think maybe some deviations from the 'script', based on more personal insights, might have led to discovering other mid-level details of the project that are left aside and could help the developing process."*
- *"the main weaknesses of this interview are due to the passive attitude and poor dialogic skills of the [analyst]. He often express himself in ambiguous terms and this make the dialogue ineffective. The fact that the client often doesn't understand the questions is strongly negative."*
- *"the customer feels that the analyst is not listening, ... the analyst is reading the paper."*

- *"They [analysts] are not listening, so they keep making the same mistakes and they sometime ask the same question twice."*

The difference between interviews and a survey questionnaire is that the former technique offers analysts the opportunity to have a face-to-face interaction to build an understanding with the customer by asking further questions based on the previous responses. But if the analyst is not carefully listening to the customer, or interrupts them in the middle of a response, or asks interrogatory questions, the benefits of face-to-face interviews get lost [6].

Analyst Behaviour

The behaviour of analysts during interviews can impact on the attitude of the customers and influence their responses. In particular, the overconfidence of the analyst can potentially lead to incorrect understanding of the problem domain and would prevent the analyst to look for alternative or contradictory information [7].

Although we did not come across too many observations regarding the behavioural aspect of student analysts, following are a few examples that were classified into this category.

- *"the ones [analysts] with professional experience looked overconfident, they thought they did not make mistakes, but they were totally out of what was asked in the assignment, and they looked like they invented the interview questions in the moment"*
- *"[analyst] looked too much in a hurry, talking too much, and had an aggressive start, he did not introduce him, and the others."*
- *" … problem is the unprofessional attitude of students who often laugh and go too fast as they are embarrassed."*
- *"the low voice and the slow attitude are really hard to tolerate."*
- *"the analyst seems a bit nervous. They do not introduce each other."*

Customer Interaction

As asserted previously, the successful outcomes of an interview activity relies heavily on the analyst-customer interaction [68]. It is typically the responsibility of the analyst to create a friendly environment that can stimulate the communication with the customer [69, 70].

'Not building rapport with the customer' at the outset of the interview was the third most observed mistake. 16 out of 28 groups made this mistake with the student analysts starting to ask direct questions from the customer straight away. This behaviour can intimidate the customer and can create an uneasy environment for the customer to properly express their ideas and vision to the analysts. The following are some of the examples from the excerpts of the interview reviews identifying mistakes of 'customer interaction':

- *"The [analysts] do not introduce themselves, moreover, even if they ask initial ice breaking questions, it sound more as an exercise and the speaker does not really sound interested in the answers."*
- *"[analyst] interrupted before the customer could complete the discourse."*
- *"They [analysts] did not create rapport, and did not ask who to talk next."*
- *"They open [interview] without building rapport"*
- *"Shaky start, he [analyst] looked not convinced in asking questions, he did not looked confident … building the rapport looked a bit fake"*
- *"In addition they [analysts] spent too much time trying to promote their ideas even when the customer doesn't agree."*

Teamwork and Planning

In the context of this study, interviews were conducted as a group task, and there were instances in which the lack of planning and coordination among team members was easily observed. In some cases, the team did not have a planned choreography of task divisions for asking questions and taking notes, and the interviewers would interrupt each other. In other cases, they did not profit from the 15 minutes allocated for the task, and they either made long pauses, or ended the interview earlier. Excerpts that represent the different mistakes observed in this group are reported below.

- *"if two people are confident, it does not work, because they interrupt each other, because they feel like being in action, and this does not appear productive for the success of the interview"*
- *"lack of coordination with additional people arriving [late]"*
- *"they did not look like a group, there was no coordination … they also did not build any rapport, making the customer defensive since the first meeting."*
- *"There was also an apparent lack of planning both for the objective of getting information (in terms of sequence of questions to ask), and for the organization of the interaction during the interview (in terms of who will speak)."*

5.1.4 Impact on the quality of elicited information in Study 1

Mistakes made during design and execution of the interview task can impact on the resulting software and system requirements [70]. The minutes of meetings in this activity were used as a tool for assessment of the student analysts' comprehension of the responses given by the customer. We further reviewed and analysed the minutes of meetings submitted by the students recorded immediately after their interview. In our review of the sample of minutes of the meetings, we traced the types of mistakes identified during our thematic analysis to what was recorded in the minutes – the minutes recorded both the original questions asked, and the responses of the customer. Although we cannot claim a direct causal relationship between specific mistakes made in the interview to what was recorded in the minutes, a general pattern was observed that the groups who made mistakes (specifically in question formulation and question omission) have articulated their understanding poorly in the minutes. We offer a few examples of this phenomenon from our analysis.

- In one case, the reviewers reported that the group was *"asking vague questions",* and we extracted several vague questions recorded from their minutes. For example, this question was recorded in the minutes: *"what do you think is the better performance".* The response to this question was recorded as: *"The owner hopes the new system can support online operations for customers, such as request tracking".* This shows that the vague question resulted in a vague response recorded, which has nothing to do with performance and reflects the poor understanding of the students.
- In another instance, the reviewers reported that the group was "*asking irrelevant questions",* we observed this question in the minutes of meeting: *"How do you have an understanding of your company daily operations such as the number of the customer and the services applied per week?".* The recorded response was: *"It depends, every week it's different. They cannot predict in advance how many people per week. If we want to know exactly, we can ask one of [the] senior employees".* This was perceived to be an irrelevant question for the first customer interview and, from the response, it appears that no relevant information was elicited.
- Another example is related to the mistake named "*asking technical questions".* In one case in the minutes the recorded question was: *"Why do you think an Internet-based service system could be useful for this project?".* The response recorded to this question was: *"Call system is problematic about tracking service staff so if it's online it will help it tracking staff and their availability which will streamline business process and save time as well".* The response does

not make any sense and indicates that the customer didn't really understand the technical question. Once again, no useful requirements information was elicited by this question.

- In all the instances where the reviewers reported the *"Question Omission"* category of mistakes, we checked the minutes of the meetings to verify that indeed those questions that were expected to be asked were not recorded in the minutes.

5.2 Study 2

5.2.1 Study Context

Our second study was conducted on different cohort of master-level students. They were given the same task as Study 1 to prepare and conduct three stakeholder interviews in three weeks. There were 138 students and they were grouped into 34 teams comprising of 3 to 4 members. Our second study differs from the first study in the following ways:

- The participants in this study are a different cohort of students from the first study.
- The role of customer for two case studies were played by two hired casual academics with no expertise in RE. None of the authors of this paper were involved in the interviews to mitigate potential researchers' bias. These individuals received basic instructions about their role-playing from the instructor on a weekly basis.
- In this study, we recorded all three interviews for all groups. For analysis, we selected only 9 groups based on their assessment marks as described below.
- The results in Study 2 are based on independent reviews of the audio files only, and we did not use customer think aloud or observations in our analysis (as was in Study 1).

5.2.2 Data Collection and Analysis

Although the pedagogical design of the task was the same, our research aims were different for this study. This time, we were aiming to analyse all three interviews in order to explore the patterns of mistakes that would emerge. We selected a sample of 9 groups (from total of 34) based on their assessment performance of final submission of SRS, i.e. three highest mark achievers, three average and the three lowest. We had a sample of 27 audio files from these 9 selected groups.[2] Three reviewers (third, fourth and fifth authors) were randomly assigned 18 audio recording each, without informing them of which interview they are listening to or which group they are reviewing. Each audio file was reviewed by two reviewers independently. We used the list of mistakes from the first study and prepared an online survey form to enable reviewers to evaluate the interviews in a systematic manner and obtain quantitative results. The survey form was designed using 5-point Likert scale from *Strongly Disagree (score 5)* to *Strongly Agree (score 1),* based on whether the reviewer observed the specific mistake in the audio recordings of the interview. The survey questions are listed in Appendix A.

Once all the reviewers filled the survey for their assigned audio files, for every audio file the average scores were calculated for every question of the survey based on the answers of the two reviewers. Lower scores for a question indicate the presence of more mistakes whereas higher scores are indicator of better quality interview (based on a smaller number of mistakes made). We analysed the data based on the group performance, the interview number and the category of mistakes. Figure 4

[2] The authors playing the role of customer and observer were not available in study 2 to have an active role during the class term, therefore we do not have customer think aloud or observation data in study 2.

presents the whole data collection and analysis process for study 2. The results are discussed in the next section.

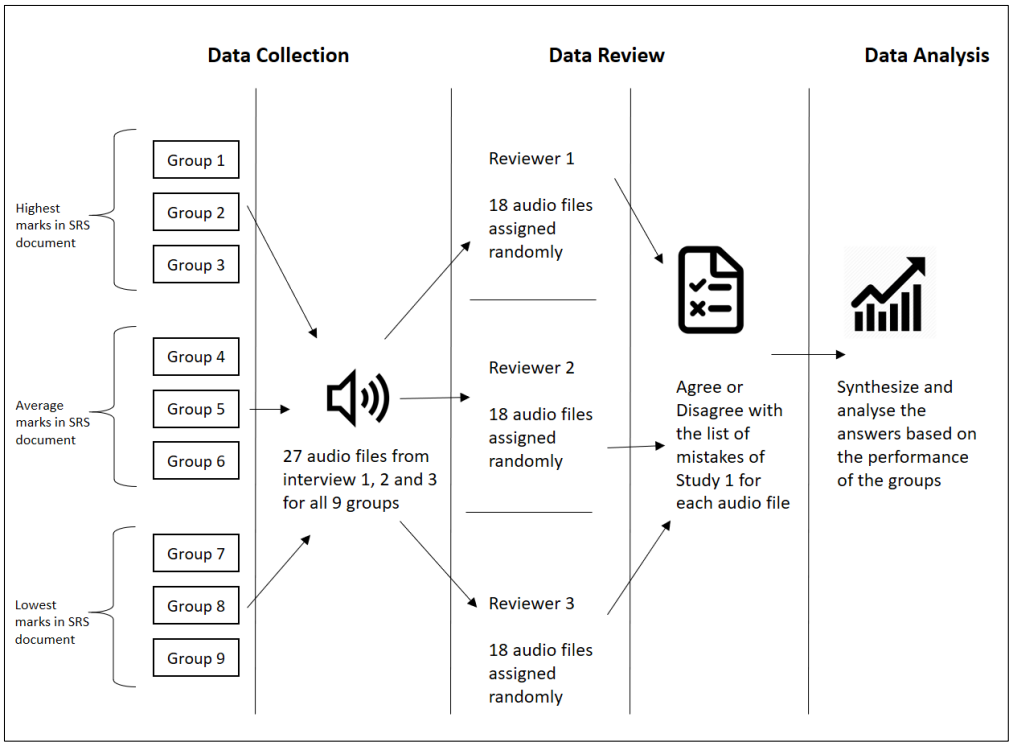

Fig. 4. Study 2 research design: data collection and analysis

5.2.3 Results from Study 2

Figure 5 shows the combined results from all 9 groups for all three interviews together. The higher the dispersion of box plots above 2.5 average score indicate the less mistakes were made in that category. A clear pattern from the results could be observed that indicates all the groups struggled with 'question formulation', 'question omission' and 'interview order' in all three interviews. Although we selected 9 groups based on their assessment mark of final SRS documents, we were unable to find any significant or clear correlation between the performance during the interview (based on number of mistakes) and the quality of the SRS document (assessment marks). The performance of the individual groups is shown by charts presented in Appendix B for all categories of interview mistakes. In this section we will discuss the nature of mistakes rather than individual groups.

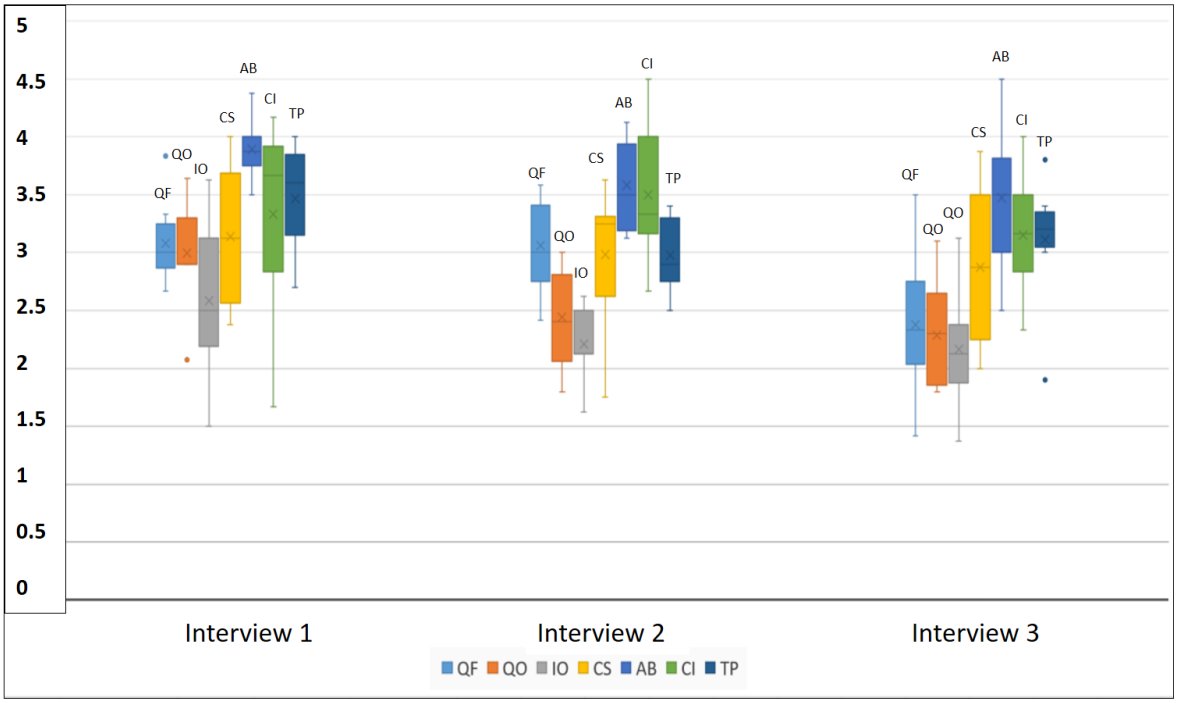

Fig. 5. Analyzing all groups for interview 1, interview 2 and interview 3 (LEGEND QF: Question formulation, QO: Question Omission, IO: Interview Order, CS: Communication Skills, AB: Analyst Behaviour, CI: Customer Interaction, TP: Teamwork and Planning)

We now unpack the results of all the categories of mistakes for all groups to gain a more explicit insight of the differences between each interview and each category of mistakes for all group. For each category of mistakes, we present two separate visualisations of the results:

- Overall performance of all groups on Likert scale 1 to 5 (1 means lowest performance – most mistakes made and 5 means highest performance – least mistakes made);
- Percentage of the frequency of individual category of mistakes made by all nine groups.

Question Formulation

Based on Fig. 6, some of the groups seem to have struggled with the question formulation in the interviews. The overall average performance of all the groups did not improve from interview 1 to interview 3. Figure 7 shows the individual elements of the *Question Formulation* theme and shows the percentage of the frequency of mistakes made by 9 groups in each interview. Which again shows that the students did repeat or made more mistakes in question formulation.

For this observation from Figures 6 and 7, we conjecture that the students had to prepare new sets of questions for every interview. For the first interview, the questions were more generic in nature (easily adopted from online resources without much modification). But in the second and third interviews they were expected to ask more domain-specific questions based on the answers elicited in their first interview. This required an element of creativity that was not necessarily needed in the first interview. This is also evident form Figure 7, as more groups start to make the mistake of *'asking incorrect question'* or *'asking irrelevant questions'* in subsequent interviews.

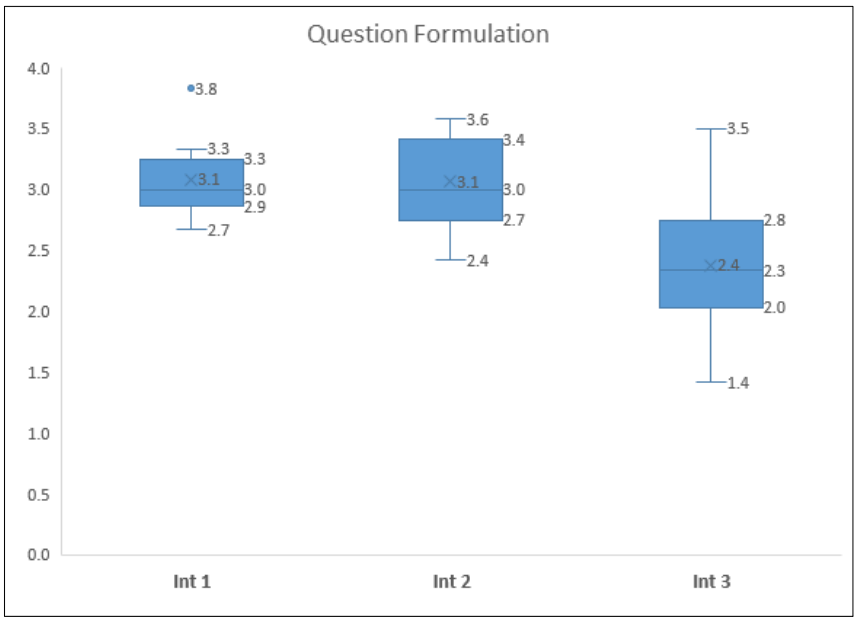

Fig. 6. Performance of all groups in Question Formulation

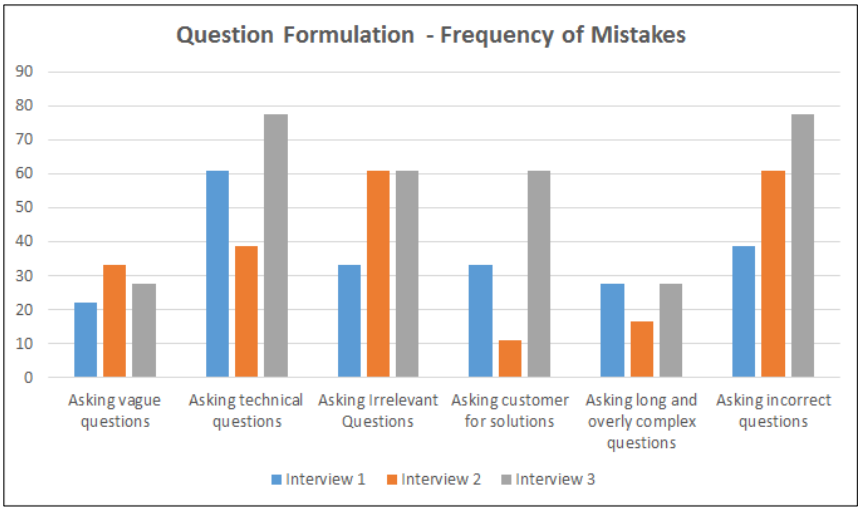

Fig. 7. Frequency of individual mistakes in Question Formulation

Question Omission

In this category the performance of all the groups have suffered and the scores for all of them were reduced rather than improved by the third interview (see Figure 8 and 9). One of the reasons may be that some relevant questions, (e.g., about business goals or success criteria of stakeholder), were already asked in previous interviews, and the students did not consider that different stakeholders may have different goals. Therefore, when confronted with potentially a different stakeholders in the second and third interviews, students did not ask about stakeholders' success criteria and expectations about the system, but focused solely on clarification questions or asking technical questions. Missing out on the opportunities for asking questions in different interviews is contextual just like the previous category *Question Formulation*. The second and third rounds of interviews required a different kind of planning in comparison to the first interview and the students seemed to be struggling to comprehend the differences.

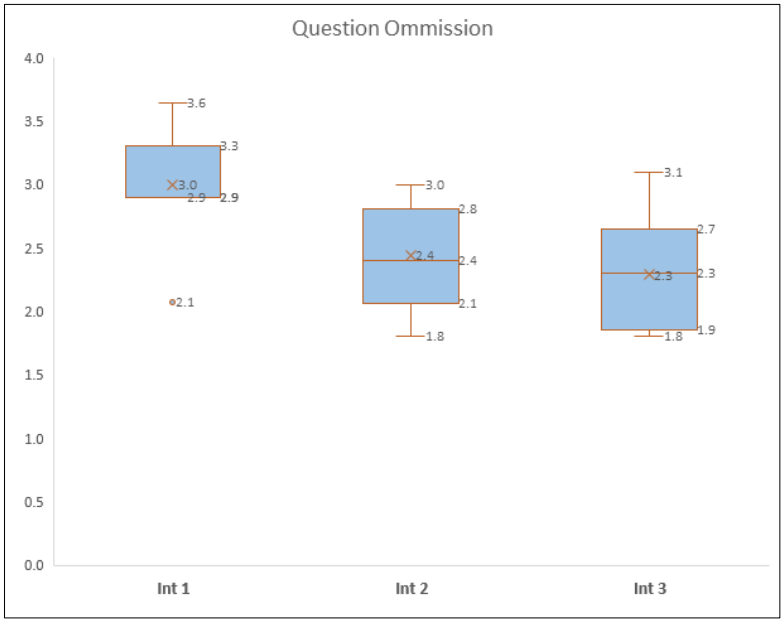

Fig. 8. Performance of all groups in Question Omission

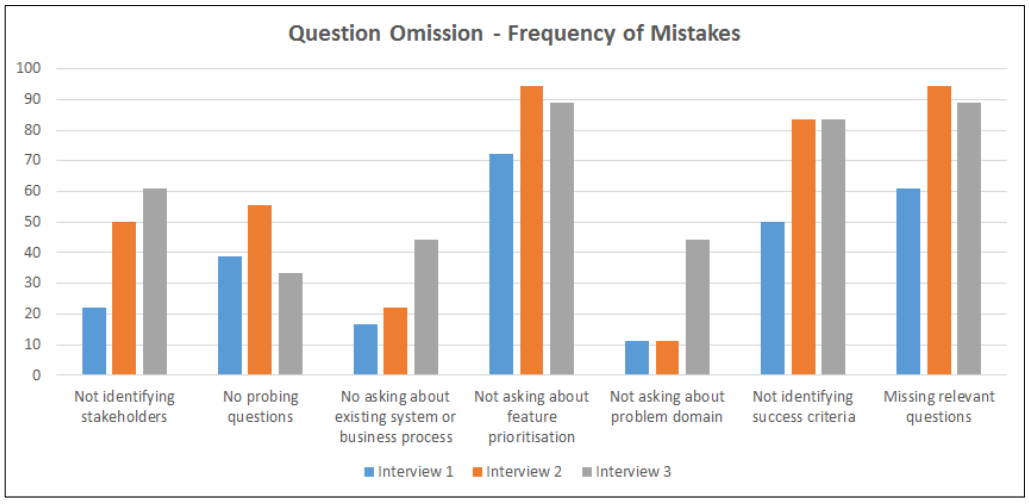

Fig. 9. Frequency of individual mistakes in Question Omission

Order of Interview Questions

As we can see in Figure 10, this aspect of elicitation interview has been a weak point for all groups throughout all the stages of interviews. Specifically, as we see in Figure 11, in the majority of the cases, the students (a) did not provide a summary at the end of the interview, and (b) tended to perform the interview as a scattered list of unrelated questions, without creating a coherent knowledge elicitation flow, in which questions are connected to each other, and (c) they performed poorly in *'opening interview'* in all three interviews. The last point may be due to the fact that the same tutor was playing the role of interviewee (even though not necessarily playing the role of the same stakeholder), and the students did not feel it necessary to build rapport with the same person playing the role of a different stakeholder.

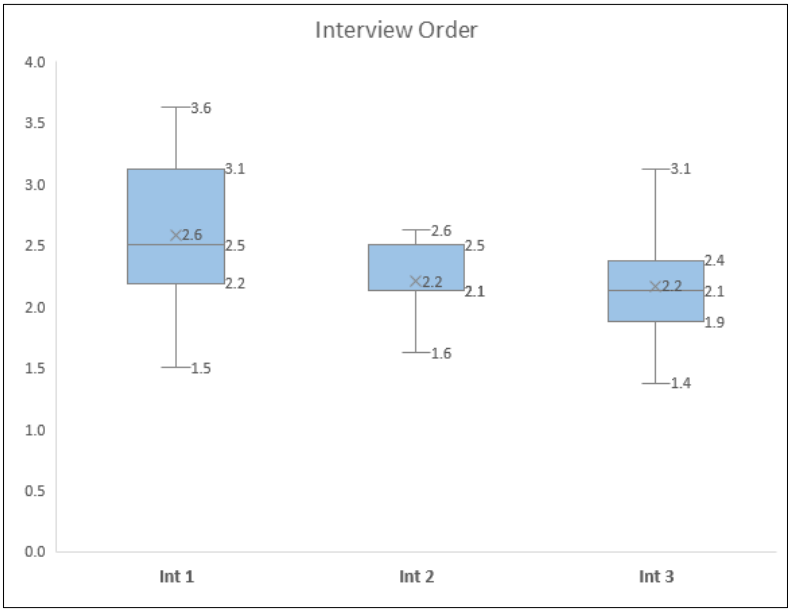

Fig. 10. Performance of all groups in Interview Order

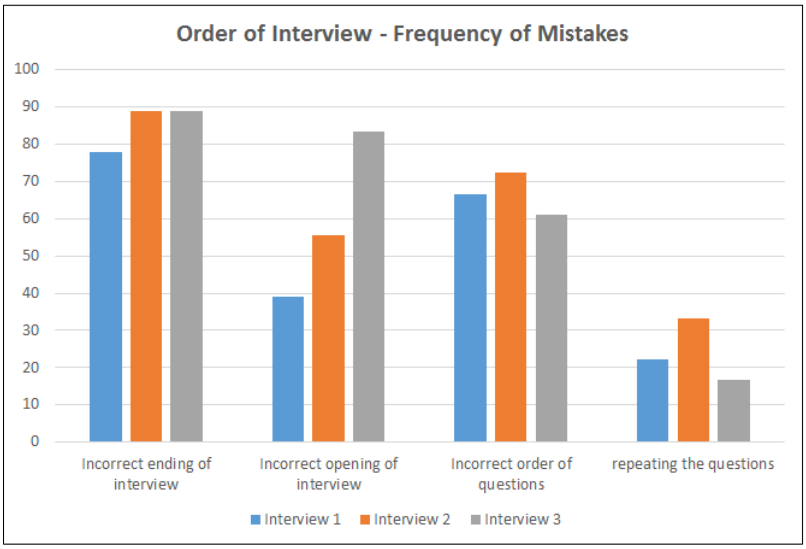

Fig. 11. Frequency of individual mistakes in Order of Interview

Communication Skills

From Figure 12, we cannot see a clear pattern of improvement in students' performance across the three interviews in their *communication skills*. We had four types of mistakes for communication skills to analyse. Figure 13 shows that the *dialogue style* and the *listening skills* seem to show improvement in subsequent interviews. This may be due to the fact that the repeated activity and feedback helped them to improve these areas, which were related purely to their social skills rather than the domain of elicitation interviews. Another noteworthy point is that groups were advised by the instructor to switch roles in each of the three interviews. That is, they were told to allow all group members to have an opportunity to ask questions. This means that some groups may have selected one group member whose communication and language skills were the best among all members to ask all the questions in all interviews. On the other hand, some groups may have taken the advice of the instructor and

have rotated the responsibility of asking questions in the interviews in order to give a chance to all members to develop this skill.

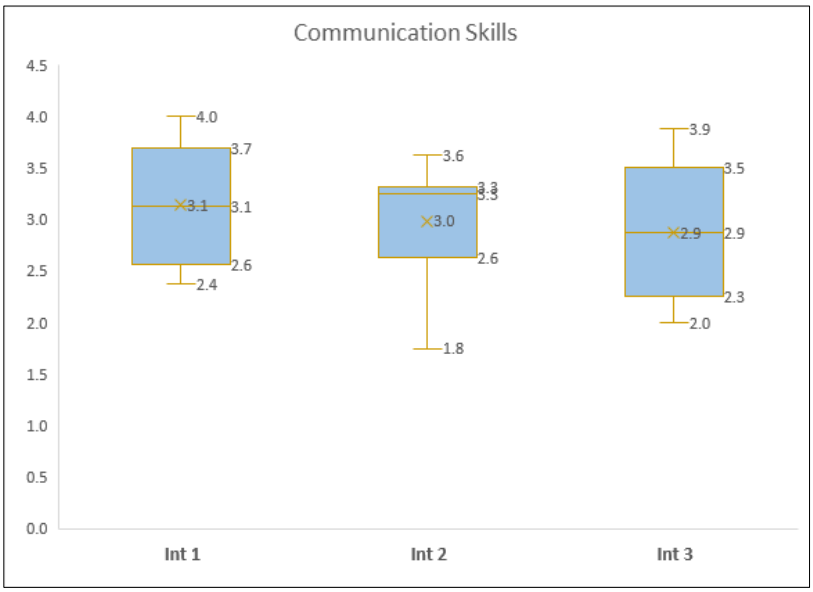

Fig. 12. Performance of all groups in Communication Skills

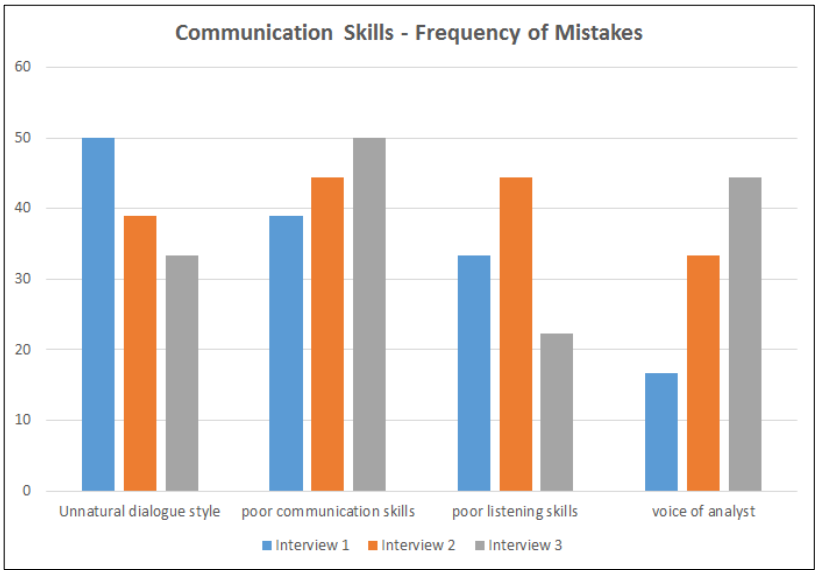

Fig. 13. Frequency of individual mistakes in Communication Skills

Analyst Behaviour

From Figure 14, this aspect of elicitation interviews has been an indicator of good performance for all the groups and remained somewhat consistent throughout the three interviews. Furthermore, it should be noticed that, on average, the percentages of mistakes are lower with respect to the previous categories (see Figure 15). However, we would like to point out that in Study 2, unlike Study 1, we did not have an observer in the room at the time of interview or did not take notes from the customer on the perception of the interview. In Study 2, the reviewers had access only to the audio recording of interviews, while the analyst behaviour may be better evaluated by considering also body language and general attitude that can often be assessed through visual observation.

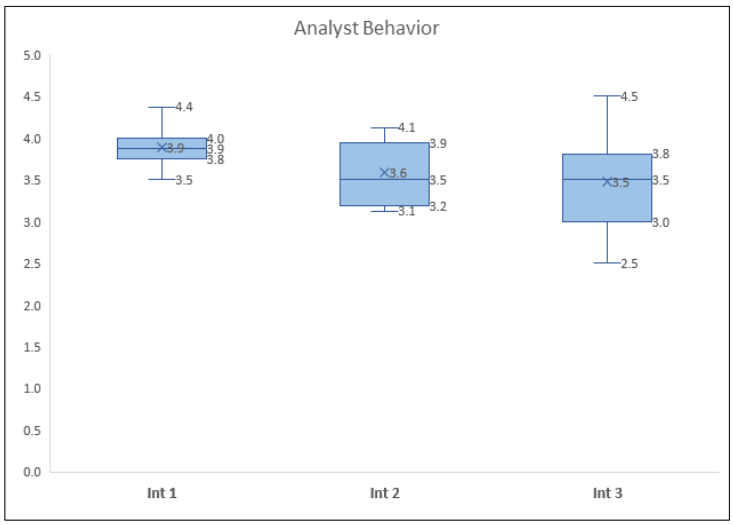

Fig. 14. Performance of all groups in Analyst Behaviour

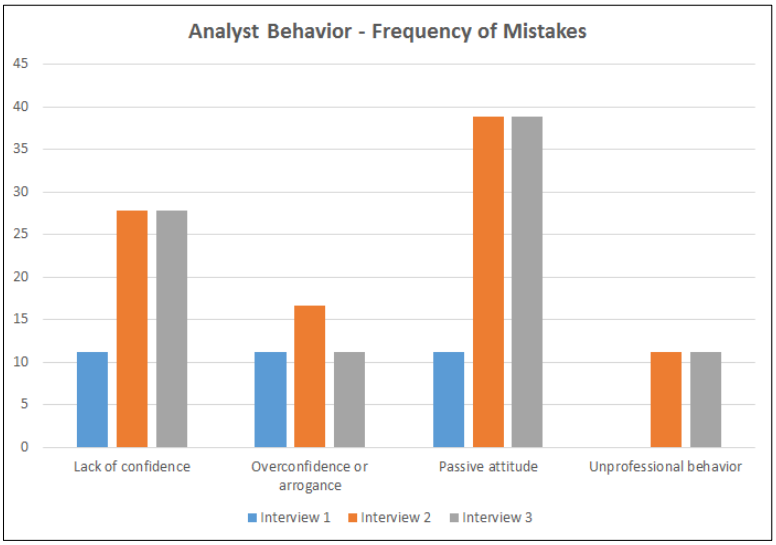

Fig. 15. Frequency of individual mistakes in Analyst Behaviour

Customer Interaction

Figure 16 shows that, overall, some of the groups have shown improvement in their customer interaction towards the third interview. However, this category only had three elements and looking at Figure 17, we see that the majority of the groups had difficulty in building *'rapport with customer'.* This particular mistake is strongly related to *'incorrect openning of interview'* in Figure 11, where in interviews 2 and 3 the students did not improve on their role-playing of analysts for different interview contexts.

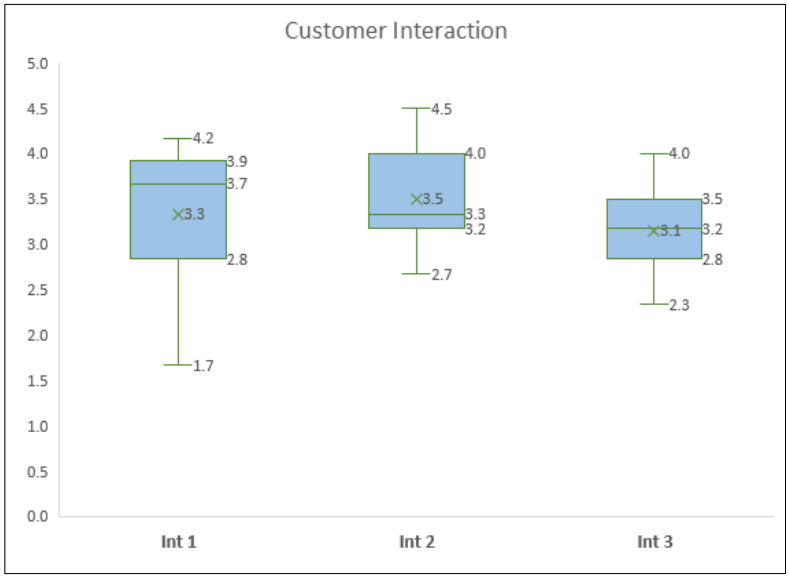

Fig. 16. Performance of all groups in Customer Interaction

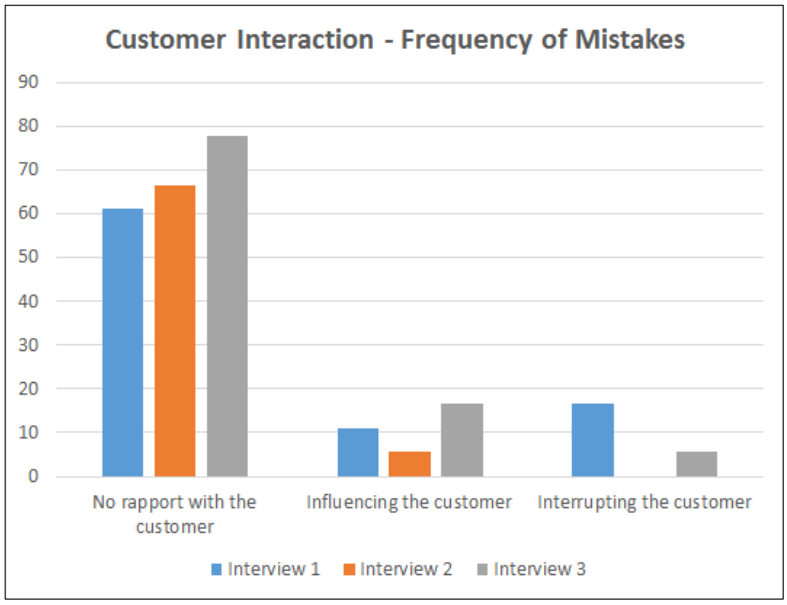

Fig. 17. Frequency of individual mistakes in Customer Interaction

Teamwork and Planning

From Figure 18, we observe that the students did not make any substantial improvements in their teamwork and planning towards the second and third interviews. Looking at the individual mistakes within this category, from Figure 19 we can see that the only mistake type where they significantly performed poorly was on their '*time management*' aspect of the interview. The students were given 15 minutes for each interview, and we can see that they did not plan well for their 2nd and 3rd interviews to prioritize and ask only the important and relevent questions. The 15-minutes limit for the interview time was due to large class and financial resources for teaching to pay for extra time of the casual academics who were playing the roles. Students were advised to rehearse their interview in order to better manage the timining of interview. There is a clear indication from verbal feedback given by groups to their tutors that not all of them took this advice.

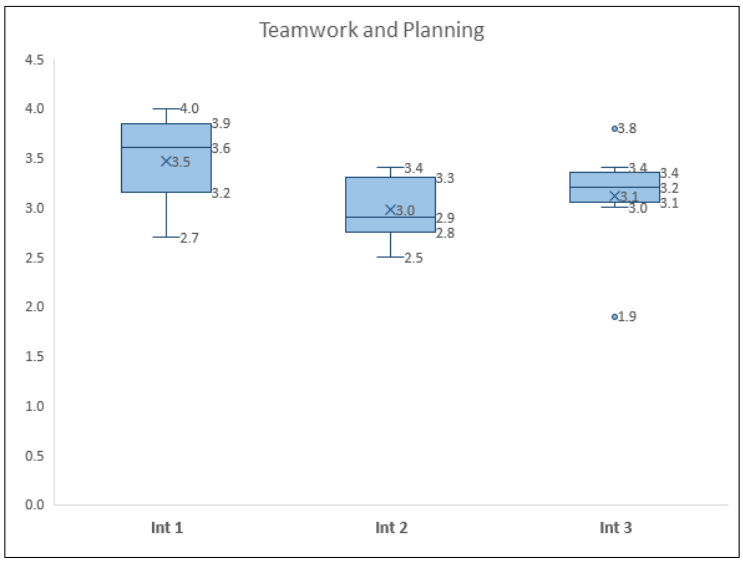

Fig. 18. Performance of all groups in Teamwork and Planning

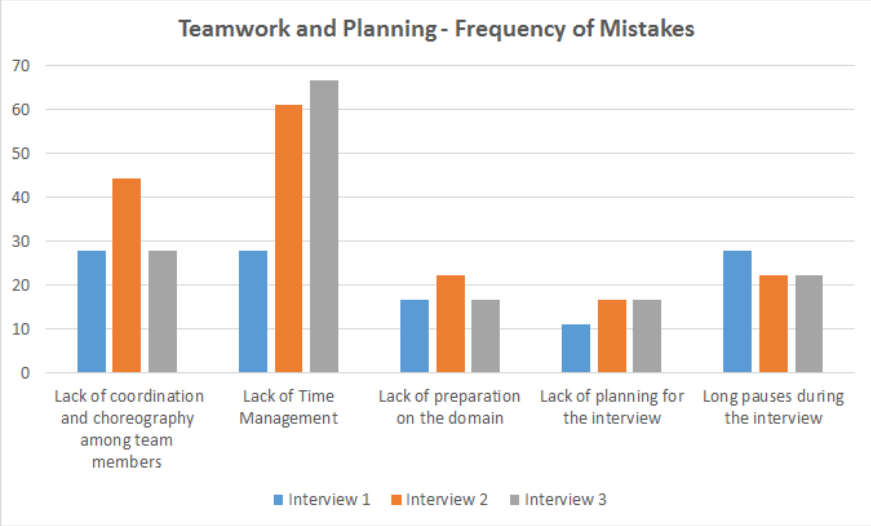

Fig. 19. Frequency of individual mistakes in Teamwork and Planning

6. Discussion

In this paper, we have presented the results from two studies on the analysis of the mistakes made by novice analysts (students) during their elicitation interviews with stakeholders. In this section, we discuss the results based on some important themes related to the interview process.

6.1 Domain knowledge

Effective requirements elicitation largely depends on the familiarity of the analyst with the problem domain [16, 17]. In our study, the students were provided project briefs for their case studies in order to do their research and planning for the interview. Requirements analysts can be more effective if they have developed a good understanding of the problem domain [15]. The domain knowledge helps the analyst in proper planning of the interview, in developing shared understanding with the customer, and gathering and organizing the acquired information into complete and clear requirements [7]. Looking at the mistakes observed, we argue that the lack of domain knowledge by the student analysts potentially contributed to several of the mistakes made in question formulation

or omissions. For example, in our category of question formulation, the mistakes observed regarding the students asking incorrect or irrelevant questions (Figures 3, 6 and 7) were mostly due to lack of understanding of the problem domain. A well-planned interview can address this issue.

Previous research in RE suggests that a lack of domain knowledge does not necessarily impact the effectiveness of the interview [17, 18, 71]. This might be true in case of expert analysts who do not have to worry about the interview process and can formulate questions correctly based on their experience of interviewing. However, for novices and students, who are experiencing their first interviews with stakeholders, the lack of domain knowledge does not help in improving interviewing skills and they end up asking wrong and irrelevant questions, hence collecting incorrect and incomplete requirements.

6.2 Minutes of Interviews

For instructors, it is important to assess the level and extent of students' ability to perform an effective interview. In order to achieve this goal, we asked students to write minutes of each interview immediately after its completion. The content of the minutes gives instructors a good indication of the level of students' understanding of the application domain and the initial requirements developed in their interview. In our studies, we observed that the students who performed well during their interview, also produced reasonably good quality minutes. However, there were also a few cases where the minutes were of poor quality even though the interview was assessed to be reasonable. So, it is not just enough to ask the right questions in the interview, but it is also equally important to listen carefully to the responses given by the customer and accurately record the understanding developed. This may be due to the fact that many groups did not present a summary of the interview discussion to the customer at the end of the interview i.e. *'incorrect ending of interview'* (See Figures 3 and 7).

6.3 Rapport with Customer

Our results of both studies revealed that students struggled with their attempt to build rapport with customer (Figures 3 and 17). Many of the cases where attempt was made to do so, especially in the case of the first interview, it seemed rather unnatural, and the utterances seemed copied from the Lynda.com online course that students accessed to prepare for the interviews. We assert that teaching students this particular skill is rather challenging as it does not come naturally to many and can also depend on the culture and ethnic background of students. We recommend that students rehearse their interviews, and if possible, record it and try to improve it with practice before coming to the real interview. However, this is a skill that would ultimately only improve with practice in real settings.

6.4 Ambiguity as a Resource

The results of Study 1 have revealed that 21 out of 28 groups have made the mistakes of asking vague questions (see Figure 3). We observed that the responses to those questions in the minutes were also ambiguous. Since the design of our assessments was developed following the corrective feedback learning paradigm, we adopted the idea presented in [21] to use the ambiguity in the interviews as a learning resource for students in preparing follow-up questions for the next round of interviews. Although study 1 only focused on the observations made during first interview, we asked the students in study 2 to identify the ambiguous responses in their minutes to formulate questions for the next round of interviews. Our observations in study 2 of the questions asked in the follow-up interviews, reaffirmed our intuition that this approach was very effective, which resulted in students improving

their understanding of the requirements and not *'asking vague questions'* (see Figure 7). We recommend this resource to all instructors as an effective teaching tool.

One of the mistakes strictly related to leveraging ambiguity is the incorrect ending of interviews, i.e., the absence of a summary at the end of each interview. In past research [21], we have observed that a summary, performed by the analyst to confirm their understanding, can often trigger further clarifications from the customer's side.

6.5 Experience versus Planning

The systematic review of Davis et al. [4] has revealed that a novice analyst, with careful planning for the interview, can elicit information equally as well as an experience one. In our first study, one of the students already had experience being business analyst and relied on his experience during the experiment rather than planning and coordinating with the group. That group made more mistakes due to his overconfidence and intimidating behaviour towards the customer. Giving customer an impression that the IT people know it all is a bad practice and impedes the formation of a trusting relationship between the two sides, which should be a critical aspect of the first interview.

6.6 Contribution to the Body of Knowledge

Our studies reported in this paper have generated new insights both in REET research as well as into the development of new pedagogical design for teaching interviews. We have developed a systematic empirical approach to study the mistakes that novice analysts make in their encounter with a customer during elicitation interviews. Our research design is substantially more rigorous that the only study of this kind previously published within the RE community [6]. Furthermore, by applying this research design in the curriculum development and performing two studies we have extended the number of previously identified mistakes [6]. These new mistakes relate to group behaviour and organization as well as attitude of the novice analysts. We have also presented the frequencies of the mistakes. Besides the contribution of our study to the Body of REET Knowledge, we believe the findings are important to educationists and trainers in the following ways:

- We reaffirm the position of role playing as a primary method of REET [10, 11], and we show how this method can be also an important source of information to directly observe students' mistakes, and possibly define more focused training strategies.
- We have presented a curriculum design that utilizes a collaborative learning environment, which is considered as an effective pedagogical approach in RE.
- Through our second study, by using the list of mistakes as a checklist (survey), we have identified the areas of elicitation interviews that the educators and trainers need to focus on when teaching the novices.

We now revisit our research questions and provide answers from the results of the two studies.

RQ1: ***What are the categories of mistakes that student analysts make during their first interview?***

> There are in total 7 categories and 34 mistakes that we observed in our study 1 (Figure 3). The categories are on abstraction, related to either the domain-related aspect of elicitation interviews (i.e., Question Formulation, Question Omission, Interview Order) or social aspect of elicitation interview (i.e., Communication Skills, Analyst Behaviour, Customer Interaction, Teamwork and Planning).

RQ2: How frequent are the categories of mistakes across subsequent interviews performed by student analysts?

> The overall performance of students in both studies (from Figures 3 and 5) indicates that they made more mistakes in domain-related categories (i.e., Question Formulation, Question Omission, Interview Order) in comparison to other categories (i.e., Communication Skills, Analyst Behaviour, Customer Interaction, Teamwork and Planning). Both studies reveal that students have struggled more in asking correct questions, opening and ending of interviews, and building rapport with customers throughout all the interviews. These are the pain points that the educators and trainers have to consider to train students better in these areas in comparison to others.

From the answer to our research questions, for educators and trainers, we have the following summarized suggestions:

- Remember to create rapport with the customer
- Remember to identify customers' goals and success criteria
- It is important to identify goals and success criteria of different stakeholders.
- Be curious about the application domain of your customer
- Do not ask too many technical questions
- Ensure your questions are expressed in a correct manner, by rehearsing the interview
- Remember to prioritize the interview questions based on the context
- Make sure that all the relevant questions are covered, by preparing for the interview
- Make and present a summary of discussion at the end of the interview

7. Threats to Validity

Both our studies were conducted under the interpretivist paradigm [72], which relies on the interpretation of the construct through the understanding of the researcher. In regards to the data analysis in this paradigm of inquiry, it is impossible to claim absolute exactness of the results free from researchers' bias. The researchers are expected to draw on their knowledge to produce insights from observations and build concepts from which their theory emerges.

7.1 Study 1

In study 1, we have tried to mitigate the risk of researcher's bias and increase the reliability of the results in our research design through independent reviews of researchers who had nothing to do with the course delivery, with two of them not even present during the interviews. One of the reviewers (4th author) is an instructor in another university and one (5th author) is a business analyst. With this in mind, we consider that we have provided sufficient details of the process of data collection and analysis in this paper to indicate the reliability and increase the trustworthiness of the results. R1, R2, O and C may have been biased by the knowledge of Donati et al. [6], when looking for mistakes. Although we explicitly asked them to do their analysis without considering this previous work, this threat could not be entirely mitigated. However, the identification of 21 additional mistakes, shows that this threat was addressed in practice. The multiple roles of the first author (being teaching assistant, researcher and the customer) and the second author (as subject instructor) are also possible sources of bias in the data analysis phase. This threat is mitigated by the presence of different, independent viewpoints in the different phases of the data collection and analysis process. The

behaviour of the students, and therefore the commission of certain mistakes, may be influenced by the relation of the students with the teaching assistant, who was playing the role of customer. Different behaviours may be observed with real customers. Although this threat could not be fully mitigated, it should be noticed that the teaching assistant had previous experience in role-playing, and this allowed her to play the customer's part with sufficient realism. This allowed a partial reduction of the confounding effect of the instructor-student relation. Furthermore, given the synchronous, human-intensive nature of interviews, we argue that the presence of two reviewers during the interviews, with different roles, allowed us to capture a larger spectrum of behavior-related mistakes.

The students were given strictly 15 minutes for all interview stages. Due to large number of groups, it was not feasible to allocate more time. This could have an impact on the quality of interview in terms of not being able to ask all the questions. However, students were given opportunity to discuss the context of the project briefs during tutorials and were asked to plan effectively for making the best use of the allocated 15 minutes.

The findings from study 1 may be valid for group interviews performed in analogous settings, i.e., with a single customer, and with one or two projects. Furthermore, the majority of the students considered are non-native English speakers, conducting interviews in English. Different results may be obtained with native English speakers, and one-to-one interviews. However, students' demographics or language skills were not the focus of our study, we were rather interested in the mistakes related to the process of elicitation interviews. One can ask the correct question in relatively bad English, whereas also one can ask incorrect questions in good and correct English.

Furthermore, the experiment was carried out by observations in only the first interview, therefore the results are entirely based on the commitment of students to have done the preparatory work before attending the interview.

7.2 Study 2

In Study 2 we had different data sources and data collection and analysis tasks, designed to remove some of the limitations of the first study. In this study, none of the authors/instructors were present at the time of interview, which was aimed to eliminate the researchers' bias from the analysis stage. That is, we did not have two data sources that were available in Study 1: (a) interview observer - O, and (b) customer think aloud – C. The interview audio files were assigned randomly to three reviewers without revealing to them the stage of interview or the group number. Furthermore, our data set was different in Study 2, in that we did not include all the audio recordings of the 3 interviews for all groups, rather we selected a sample. We considered groups that obtained different grades for their final SRS (3 of the highest marks, 3 of the average marks and 3 of the lowest marks), arguably assuming that this would cover groups with different observable behaviour and, in turn, observable mistakes, also during interviews. Another threat for the second study is related to the approach adopted to count the mistakes. This was performed based on a questionnaire (Appendix A), which required personal judgment, hence subjective evaluation. To mitigate the subjectivity threat, for each interview, two experts reviewed each interview, and filled the questionnaire independently. The presented results are the average of the scores given by each expert.

Another point to consider in the observation of the all the reviewers from Study 1 and Study 2 is that the person playing the role of the customer in Study 1 and Study 2 may also have impacted the results. In Study 1, it was the teaching assistant (first author) who is experienced in RE teaching, had previous practice of role-playing activities and was involved in the research. In study 2, the casual academics

were not experienced in RE (they were PhD students in computer science), and were involved in role-playing activity for the first time. However, we argue that, in study 2, this adds to the authenticity of assessment task based on guidelines of Dawson's tricks [59] by presenting *"uncertain and naive customer"* who is not the teacher and hence the students cannot fall for the assumption that the teacher (playing the customer role) should provide correct, clear and consistent answers in all three interviews.

The results of Study 2 are applicable for similar settings, i.e., three group interviews for the same product, and different types of stakeholders. Different results may be obtained with stakeholders of the same type for each interview, and in case of one-to-one interviews. Observations on native speaking language reported for Study 1 apply also to Study 2.

In Study 2, one person played the role of different stakeholders in three interviews. Having the same person playing different roles may impact on the realism of the elicitation process, and on the performance of students, especially concerning the task of building rapport with the customer. In Study 2, this limitation was due to constraints on the hiring budget for the assessment.

It is also important to notice that the survey form used to evaluate the interviews was developed based on mistakes identified for first interviews with the sponsor. Frequency of mistakes that are specific to other contexts (different interview stages, different stakeholders) have not been captured.

8. Conclusion and Future Works

We have presented a research design for conducting an observational study of mistakes that novices make in requirements elicitation interviews. We also provided the results from the qualitative analysis of empirical data collected from multiple sources in this study. The significant number of mistakes observed and their classifications into 7 distinct themes provide a useful resource for educationists and trainers who wish to include elicitation interview training in their curriculum. We have also identified the aspects of elicitation interviews where the students struggle the most across three separate interviews. These aspects are indeed the ones that educators need to pay particular attention to.

Education research has shown that, in general, the pedagogical approaches that we have utilized are effective for education and training, namely: collaborative learning, role-playing activity, corrective feedback learning, and authentic assessment. We believe that all of our contributions are not only useful in a university setting but also equally valuable in RE industry training.

The students did not improve much towards later interview stages. This suggests that giving general class feedback to the students, as in our current pedagogical approach, appears not to be enough for them to learn from their mistakes. We therefore argue that novel pedagogical approaches are needed to improve students' abilities and awareness of their mistakes. To this end, we are currently developing and experimenting a novel training protocol, in which the student themselves are required to listen to their own interview recordings and identify their mistakes, based on the questionnaire used also in the current study. This approach, which includes phases of self-assessment and a peer-review, will hopefully provide more guidance to the students.

In the future, we plan to review not only the audio recordings but also the video recordings of the interviews for mistakes present in non-verbal communications, along the lines of Karras et al. [73]. Indeed, some mistakes associated with inappropriate and unprofessional behaviour, e.g., arriving late, or not looking at the customer, can be clearly observed only with a video analysis. We argue that these

mistakes may have a major impact on the rapport and trust-based relationship that the analyst is supposed to establish with the customer.

9. Acknowledgements

- Authors would like to thank all the students who participated in this project.
- This research was approved by the University of Technology Sydney's Research Ethics committee, under the number ETH17-1266.
- This work was partially supported by the National Science Foundation under grant CCF-1718377

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Appendix A: Interview Questionnaire

Please rate your agreement with the following statements about QUESTION FORMULATION * [Strongly Agree (1), Agree (2), Not sure (3), Disagree (4), Strongly Disagree (5)]

The analyst asked vague questions
The analyst asked technical questions
The analyst asked questions that appeared irrelevant to me
The analyst asked the customer for solutions
The analyst asked long and overly complex questions
The analyst formulated their questions in a way that appeared incorrect to me
The analyst asked vague questions
The analyst asked technical questions
The analyst asked questions that appeared irrelevant to me
The analyst asked the customer for solutions
The analyst asked long and overly complex questions
The analyst formulated their questions in a way that appeared incorrect to me

Please rate your agreement with the following statements about QUESTION OMISSION * [Strongly Agree (1), Agree (2), Not sure (3), Disagree (4), Strongly Disagree (5)]

The analyst DID NOT ask for additional stakeholders
The analyst DID NOT ask probing questions to confirm their understanding
The analyst DID NOT ask about the existing system or business process
The analyst DID NOT ask questions about feature prioritisation
The analyst DID NOT ask information about the problem domain
The analyst DID NOT identify goals and success criteria
The analyst DID NOT ask all the questions that I consider relevant
The analyst DID NOT ask for additional stakeholders
The analyst DID NOT ask probing questions to confirm their understanding
The analyst DID NOT ask about the existing system or business process
The analyst DID NOT ask questions about feature prioritisation
The analyst DID NOT ask information about the problem domain
The analyst DID NOT identify goals and success criteria
The analyst DID NOT ask all the questions that I consider relevant

Please rate your agreement with the following statements about ORDER OF INTERVIEW * [Strongly Agree (1), Agree (2), Not sure (3), Disagree (4), Strongly Disagree (5)]

The analyst DID NOT perform a summary at the end of the interview
The analyst started the interview by asking direct questions about the system
The analyst asked questions in an order that appeared incorrect to me
The analyst repeated the same questions multiple times
The analyst DID NOT perform a summary at the end of the interview
The analyst started the interview by asking direct questions about the system
The analyst asked questions in an order that appeared incorrect to me
The analyst repeated the same questions multiple times

Please rate your agreement with the following statements about COMMUNICATION SKILLS * [Strongly Agree (1), Agree (2), Not sure (3), Disagree (4), Strongly Disagree (5)]

The dialogues style used by the analyst appears unnatural to me
The analyst showed poor communication skills
The analyst showed poor listening skills
The analyst spoke with a low and unclear tone

The dialogues style used by the analyst appears unnatural to me
The analyst showed poor communication skills
The analyst showed poor listening skills
The analyst spoke with a low and unclear tone

Please rate your agreement with the following statements about ANALYST BEHAVIOUR * [Strongly Agree (1), Agree (2), Not sure (3), Disagree (4), Strongly Disagree (5)]

The analyst showed lack of confidence
The analyst appeared overconfident or arrogant
The analyst showed a passive attitude
The analyst showed a behaviour that appeared unprofessional to me
The analyst showed lack of confidence
The analyst appeared overconfident or arrogant
The analyst showed a passive attitude
The analyst showed a behaviour that appeared unprofessional to me

Please rate your agreement with the following statements about CUSTOMER INTERACTION * [Strongly Agree (1), Agree (2), Not sure (3), Disagree (4), Strongly Disagree (5)]

The analyst DID NOT create rapport with the customer
The analyst tried to influence the customer
The analyst interrupted the customer
The analyst DID NOT create rapport with the customer
The analyst tried to influence the customer
The analyst interrupted the customer

Please rate your agreement with the following statements about TEAMWORK and PLANNING * [Strongly Agree (1), Agree (2), Not sure (3), Disagree (4), Strongly Disagree (5)]

There was lack of coordination and choreography among team members
The analyst did NOT manage their time in a proper way
The analyst showed a lack of preparation on the domain
The analyst looked like they did not plan the interview
There were long pauses during the interview
There was lack of coordination and choreography among team members
The analyst did NOT manage their time in a proper way
The analyst showed a lack of preparation on the domain
The analyst looked like they did not plan the interview
There were long pauses during the interview

Appendix B: Group performance based on SRS Document Assessment

We had three groups each for top marks, average marks and the lowest marks. We were interested to see whether their performance during the interviews had any correlation with their understanding that lead to writing the SRS document. For ease of visualisation we have divided the interview themes into further two categories i.e. Domain specific aspects of elicitation interview (Question Formulation, Question Omission and Interview Order) and Social aspect of interview (Communication Skills, Analyst Behaviour, Customer Interaction, and Teamwork and Planning). The higher scores show better performance and the lower scores show poor performance.

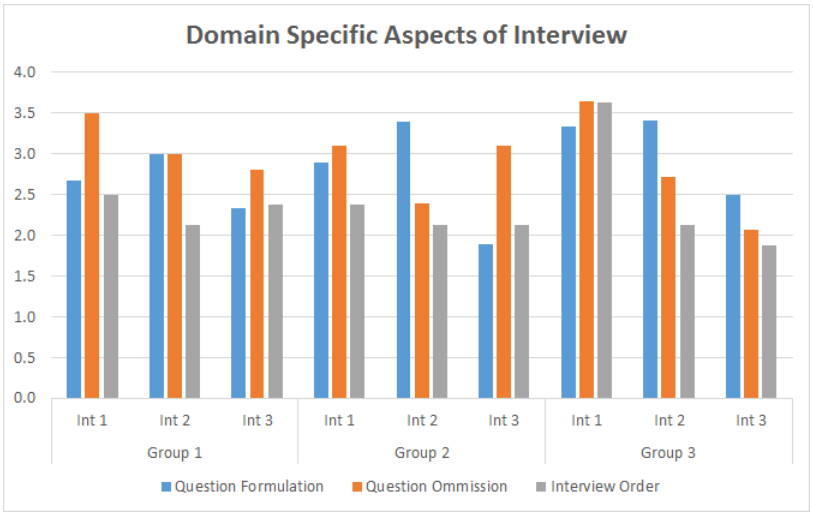

Fig. 20. Performance of Groups with top marks in Domain Specific Aspects of interview (Int)

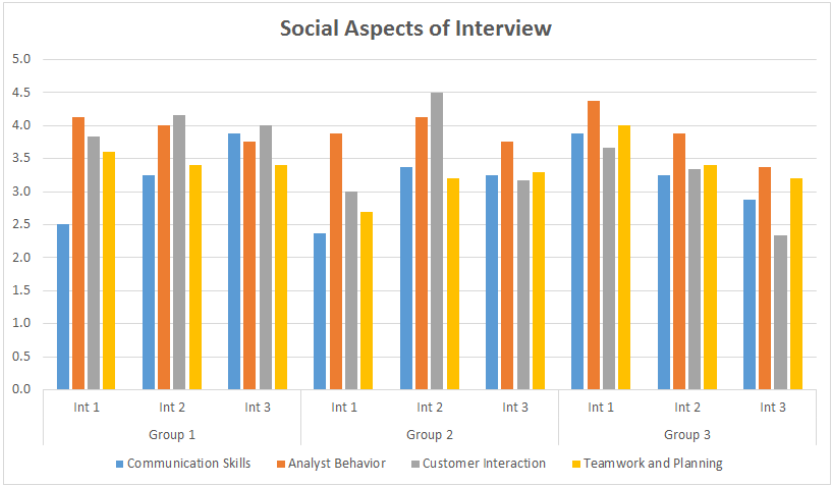

Fig. 21. Performance of Groups with top marks in Social Aspects of interview (Int)

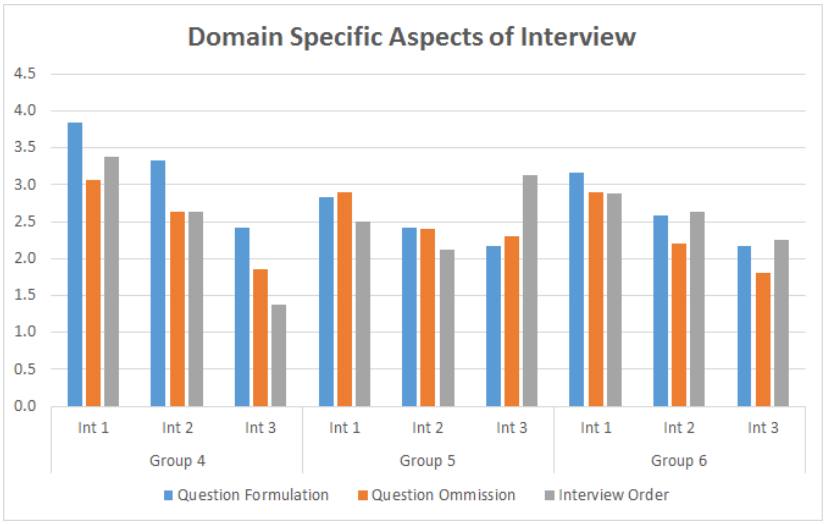

Fig. 22. Performance of Groups with average marks in Domain Specific Aspects of interview (Int)

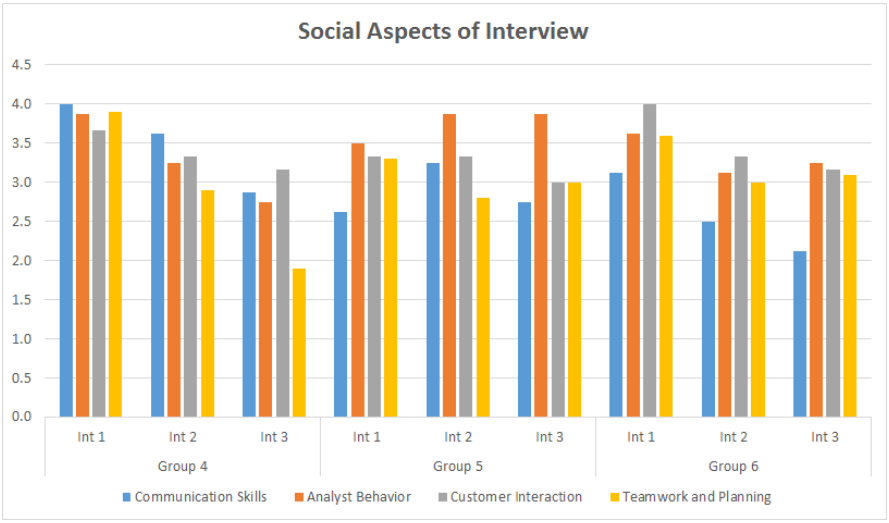

Fig. 23. Performance of Groups with average marks in Social Aspects of interview (Int)

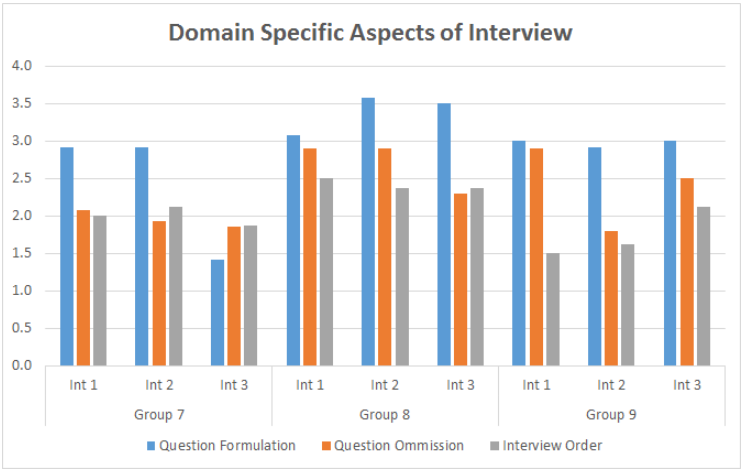

Fig. 24. Performance of Groups with lowest marks in Domain Specific Aspects of interview (Int)

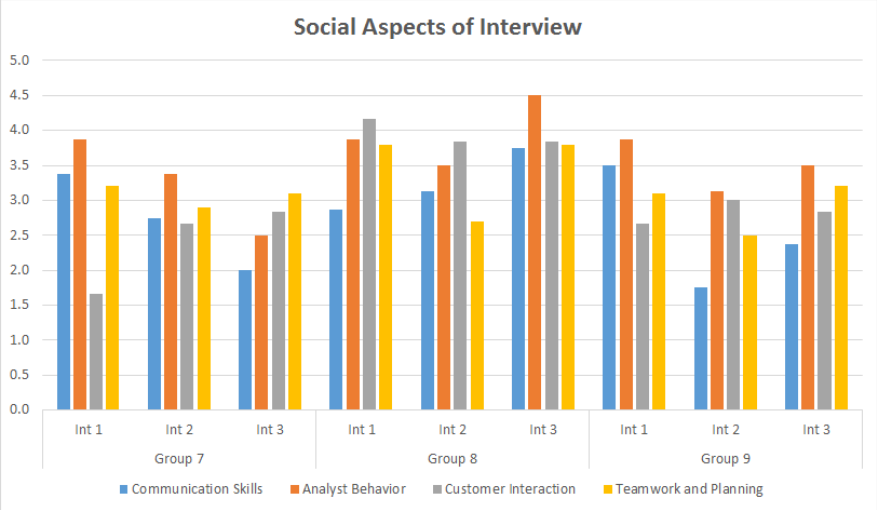

Fig. 25. Performance of Groups with lowest marks in Social Aspects of interview (Int)