Exploring *focus groups* as a tool for knowledge acquisition and conceptualization phases in ontology engineering

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Abstract

Focus Groups (FGs) bring together domain experts to discuss ideas and co-design in a collaborative way. Among the techniques suggested by Ontology Engineering Methodologies for knowledge acquisition, FGs are not suggested. In this work, we propose a preliminary experiment to assess the potentialities of FGs to validate a given conceptualization and elicit implicit and tacit knowledge through collaborative discussion. The experiment consisted in 5 FGs – guided by two analysts and a set of Competency Questions (CQs) – with different numbers of participants, who were asked to share their opinions over a conceptual map in the field of Medical Devices (MDs) and Health Technology Assessment (HTA). All experts had backgrounds in MDs and HTA in roles such as manufacturers, developers, clinicians, or managers in charge of introducing new MDs within their healthcare facilities.

This work sketches the qualitative results from the FGs' discussions and presents the quantitative results of a questionnaire aimed at investigating participants' perspectives on FGs' knowledge acquisition and flexibility features and analyzing their experiences, satisfaction, perceived role, and collaboration. Although preliminary, the results indicate that the FG has the potential to elicit implicit and tacit knowledge and that using CQs to guide the discussion can result in an enhanced domain analysis phase during Ontology Engineering.

Keywords

Ontology engineering, Knowledge acquisition, Collaborative ontology engineering, Focus group, Knowledge elicitation techniques

1. Introduction

A well-known problem pertaining to the *domain analysis and conceptualization* phase [1] of Ontology Engineering (OE) is the "knowledge acquisition bottleneck" [2]: elicitation and acquisition of relevant knowledge is a very time-consuming and expensive activity. Nonetheless, knowledge acquisition is the essential core of OE, and thus, it is a very delicate activity upon which the success of the developed ontology relies. Knowledge can be

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extracted from documents (laws, regulations, handbooks, etc.), schemas, and domain experts. Expert-based knowledge and its acquisition are considered fundamental to ensure the ontology's shareability and credibility [3], [4]. Therefore, several OEMs provide some techniques that can support the collaborative acquisition of relevant knowledge from experts.

However, the collaborative approaches involving domain experts imply three main issues. First, experts are often busy and can devote little time to these activities [5]. Second, in large contexts (e.g., medium or large enterprises, organizations, multidisciplinary teams, etc.), the knowledge necessary to develop an ontology may be distributed among many experts [6]. Third, experts may struggle to make their knowledge explicit because it is routinized [7], [8]. This also underlines the difficulty related to the acquisition of implicit and tacit knowledge [9], [10]. The awareness of the role of domain experts contributed over the years to the development of collaborative OEMs, which encompass several knowledge acquisition techniques involving domain experts and ontology engineers. Such techniques aim to limit the knowledge acquisition bottleneck while minimizing the amount of time and effort necessary to elicit the knowledge.

Nonetheless, the focus group (FG) [11] is not considered among these techniques. The FG is a qualitative research method that brings together a group of persons (usually no more than 10 and less than 6 for particularly complex domains [12]) useful for confirming or refuting pre-existing beliefs and for understanding the reasons "why" something occurs (especially in contexts characterized by a lack of explicit knowledge). It resembles a "group interview" in which selected individuals discuss specific topics guided by analysts. It is typically adopted to support "co-designing" activities by stimulating experts' discussion. The FG usually relies on loose questions to guide the discussion, although participants are free to "roam" from one end to the other of the topic. With the availability of online technologies, FGs became digitally enabled and more popular, contributing (in their digital form) to mitigating the unavailability of experts [13]. Considering its collaborative approach based on group discussions and its use as a co-design tool, the FG resembles both collaborative OEMs [14] and traditional knowledge elicitation techniques [5].

This paper argues that the FG can be valuable for OE's knowledge-acquisition activities. We believe that FGs have the potential to support the elicitation of implicit and tacit knowledge while reducing the time required for experts. Due to its collaborative feature, it is plausible that FGs could play a role in defining the conceptualization of a domain during an OE process. To the best of the authors' knowledge, the role of focus groups in OE activities has not been investigated yet. Therefore, we used the FG within the OE process of a domain ontology to represent expert knowledge on Medical Devices (MDs) to support manufacturers, healthcare managers, clinicians and Health Technology Assessment (HTA) analysts. We describe an experiment aimed at:

- Assessing whether the focus group is a valuable mean for the validation of existing conceptualizations;
- Elicit implicit and tacit knowledge to be integrated into an existing conceptual model.

The remainder of this paper is organized as follows: Section 2 surveys the main knowledge acquisition techniques adopted in knowledge engineering; Section 3 describes the MDs domain where the experiment takes place, presenting the quantitative results. Section 4 discusses the results gathered, underlining some limitations and possible future research activities. Finally, the Conclusions summarize the main outcomes of this work.

2. Related work

Knowledge acquisition techniques aroused the interest of ontologists when it became clear they could have significantly impacted the "knowledge elicitation bottleneck", thus supporting OE. Many literature reviews survey the techniques used in knowledge acquisition [5], [7], [15]. According to Gavrilova, knowledge acquisition techniques can be classified – based on the analysts' and experts' roles – into *analyst-leading* (structured, unstructured, or semi-structured interviews, questionnaire), *expert-leading* (storytelling, round table, brainstorming), and *expert-analyst collaborating* (role games, verbal protocols).

It is ascertained that different techniques can elicit different types of knowledge, and some techniques are more arduous to administer or may result difficult for experts – thus impacting the quality of the elicited knowledge [7]. Over the years, OEMs have suggested several techniques, depending on the role foreseen by experts within the methodology.

Unlike knowledge acquisition techniques, the FG was born as a group-based qualitative methodology for gathering participants' opinions on a specific topic and as a tool for collaborative design. We argue that, different from traditional knowledge acquisition techniques, the FG has unique features that make it appropriate for OE's domain and conceptualization phase's activities.

3. Focus Groups in OE: the case of Medical Devices' domain ontology

3.1. Developing a MD ontology for HTA

The necessity of developing a domain ontology on MDs arose from the observation that valuable knowledge from qualified individuals (experts) on this topic could support several stakeholders in the Italian context in the selection of MDs in clinical settings. For example, healthcare managers – i.e., those professionals involved in the operational, administrative, and strategic aspects of a healthcare facility – can use expert knowledge of MDs to compare available alternatives and the impact(s) they may have on their process and organization. Concurrently, HTA analysts – i.e., internal or external professionals involved in HTA activities for an organization – can benefit from such expert knowledge to support their HTA analysis.

The authors addressed the problem of gathering and formalizing expert knowledge on MDs and HTA practices by recurring to the development of a domain ontology, which will ultimately serve as the backbone of a Decision Support System. To develop the ontology, the authors relied on an existing OEM (AgiSCOnt [16]). The knowledge acquisition phase took advantage of scientific literature, European regulations ([17], [18]), existing classifications pertaining the Italian healthcare professions, existing databased (EUDAMED [19], the

European database listing existing MDs), well-known international classifications for diseases and impairments identification ([20] [21]), and an existing ontology (the HTA Core model [22]) – partially describing some of the features investigated in our ontology. Since many different domains were involved, it appeared clear that domain analysis activities would have required the collaboration of domain experts to identify the relationships occurring among those domains and to acquire knowledge related to the HTA processes in practice.

For this, three domain experts from two healthcare organizations in Italy were interviewed using unstructured interviews. These were two heads of the HTA units of their respective hospitals and the head of the Innovation and Research department. The experts were interviewed separately by a management engineering PhD student (with experience in HTA) and an ontologist. During each interview, the experts detailed the HTA processes within their organizations.

The results of the interactions with the domain experts consist of the development of a list of 15 Competency Questions (CQs)[23], a glossary, and a Conceptual Map (CM) [24].

The CM is a graphical representation of the MDs domain investigated and connects concepts via relationships, allowing to specify attributes for the concepts. Although the interactions with domain experts and literature search allowed us to sketch a detailed map, we devised an experiment with FGs to acquire more implicit and tacit knowledge from professionals dealing with HTA in their working activities.

3.2. Experimenting with Focus Groups in the *conceptualization* phase

The experiment involved 23 experts selected from Italian healthcare structures, researchers, and MD companies. Thus, the sample of participants covered different HTA-related professional roles, ranging from physicians (participating in HTA activities), manufacturers of MDs, and researchers. The participants were asked to take part in a FG (duration: 1.5 hours [11]) to discuss a conceptualization of MDs and HTA (i.e., the CM). Five FGs were organized (four using an online communication platform, one in presence): the first involved 7 participants, the second and the third 3 participants each, the fourth 6 participants, and the fifth 4 participants.

Each FG started with a brief introduction aimed at providing instructions and explaining the main purpose of the ontology-based system, then proceeded with illustrating the conceptualization. For exemplification, the CM was instantiated with the *da Vinci* surgical system, a well-known MD in the Italian context. Two analysts adopted the CQs to guide the discussion among experts, with the aim of letting the participants describe their in-practice experience in HTA. The participants were able to see, "navigate", and discuss the CM. The analysts registered specific questions, comments, and suggestions pertaining the CM.

Fifteen days after their participation in the FGs, participants were asked to complete a questionnaire (modelled after [25]). The questionnaire (Table 1) is composed of seven sections, for a total of 25 items – with the possibility of adding written notes at the end of each section. Participants were asked to express their agreement for each item, ranging from "1 – totally disagree" to "5 – completely agree"; results were collected anonymously using a web form. Out of 23 participants, 19 (83% response rate) responded to the questionnaire (completely).

The questionnaire investigates *knowledge acquisition* and *flexibility* aspects related to the FG as a tool, and analyzes the quality of the participants' *experience* and their *satisfaction*, as well as their *perceived role and collaboration* during the FG and *perceived effort*.

Table 1. The list of items composing the questionnaire (item 20 requires a Yes/No answer).

Sect.	#	Item description
Knowledge acquisition	1	The FG I participated in allowed me to have an overall vision of the problem
	2	The FG I participated in allowed me to delve deeper into some aspects relating to medical devices that I knew little about before
	3	The FG allowed me and the group to address all the critical aspects that were highlighted during the discussion
Clarity & simplicity	4	The instructions given to me during the FG were clear
	5	I have always fully understood all aspects relating to the Conceptual Map that were addressed during the FG
	6	I had sufficient indications to provide my contribution during the FG
Flexibility	7	In my opinion the FG tool could also be used to discuss and refine other conceptual maps (relevant to any field)
	8	I believe that the FG is a tool capable of accommodating the needs of all participants in order to discuss the conceptual map
	9	I believe that the FG is a sufficiently informal and unstructured tool that allows you to explore a conceptual map easily
	10	The FG applied to the conceptual map allows us to highlight and correct its errors
	11	During the FG, I was able to express my opinions and share my ideas to propose changes to the concept map
Perceived role & collaboration	12	During the FG, I was able to dialogue with other participants in a constructive way on one or more topics
	13	As a FG participant, I was able to contribute according to my knowledge and skills
	14	I felt part of a working group and involved for the entire duration of the FG
	15	I felt legitimized to express my opinion during the FG
	16	I believe that the FG is a tool that facilitates collaboration regarding the modification of conceptual maps
	17	I felt involved for the entire duration of the FG
Perceive	18	The FG had an adequate duration

	19	The FG required a lot of attention
Experience	20	I had already taken part in other FGs during my professional experience for co-design purposes [YES/NO]
	21	I believe that the introductory part explaining the method and the theoretical elements involved in the Conceptual Map was of adequate duration
	22	I believe that introducing the problem through the CQs facilitates the exploration of the map
Satisfaction	23	The experience of participating in the FG was satisfactory
	24	The experience of participating in the FG was interesting
	25	Strengthened by this experience, if it were proposed to me, I would be interested in participating in another FG (relating to any topic)

3.3. Focus Groups qualitative and quantitative results

All the participants deemed the conceptualization they were shown correct. They found the CM could represent the fundamental MDs, HTA, process, and health-related features pertaining to the domain at hand. Second, they suggested some attributes to be added to existing concepts to enrich the quality of the CM, and they suggested the introduction of new concepts to complement (and complete) the existing ones. Moreover, during one of the FGs, a participant pointed out that the three concepts are categories that specify an other concept: the concepts *Screening*, *Diagnosis*, and *Medical and surgical interventions* should not be disjointed as they are specifications of the broader concept *Medical device*. The quantitative results of the questionnaire are presented in Table 2.

Table 2. The quantitative results for the questionnaire; for each question, mean (M) and standard deviation (SD) values are reported; the right column reports the section's M.

Section	Q#	M	SD	Section M
Knowledge acquisition	1	4	0.58	*3.84*
	2	3.57	1.01	
	3	3.95	0.84	
Clarity & simplicity	4	4.63	0.49	*4.31*
	5	3.84	0.96	
	6	4.47	0.61	
Flexibility	7	4.10	1.05	*4.23*
	8	4	0.82	
	9	4.31	0.67	
	10	4.15	0.96	
	11	4.58	0.60	
	12	4.63	0.59	*4.39*

Perceived role & collaboration	13	4.21	0.71	
	14	4.16	0.89	
	15	4.68	0.58	
	16	4.37	0.83	
	17	4.31	0.75	
Perceived effort	18	4.05	1.02	*4.07*
	19	4.10	0.81	
Experience	20	10 yes; 9 no	-	*4.10*
	21	4.31	0.67	
	22	3.89	0.80	
Satisfaction	23	4.16	0.69	*4.23*
	24	4.42	0.77	
	25	4.10	1.10	

Only one participant wrote one comment for the section *Perceived effort*, indicating that "*although the participants were experts, it is hard to deepen all the topics in a one-hour FG*".

4. Discussion

In this Section, the results depicted in the previous Section are discussed, and a few limitations are highlighted.

4.1. Qualitative and quantitative results

The participants were able to provide feedback and suggest modifications to the CM presented. Although the FGs lasted one hour, the exemplification through an instance enabled them to browse the map in all its extensions. Considering the feedback acquired, it is possible to assume that FGs were able – to some extent – to enrich the conceptualization proposed: the participants provided valuable comments on some issues that would have otherwise remained implicit or tacit. Within the limits of this experiment, it is possible to assert that the FG served the purpose of "validating" the original CM and enriching it with significant additions.

It is also worth observing that one participant provided a suggestion pertaining to *how to* model the knowledge in the CM; thus, the discussion was also able to elicit an *authoring* suggestion. This phenomenon is not new in those OEMs characterized by a high level of collaboration among experts and ontologists ([16], [25]).

Although preliminary, a few considerations can be drawn also from the questionnaire's results. The *knowledge acquisition* section of the questionnaire globally scored positively (considering 3 as the neutral option of the 5-points Likert scale). While all participants agreed that the FG enabled them to acquire an overall vision of the domain(s) at hand (Q1), Qs 2 and 3 scored slightly less: this could be motivated, respectively, by the fact that experts did not deepen any previously unknown aspect and that the duration of the FG did not allow an in-depth discussion of all the topics involved (see also the comment provided by one of

the participants). Participants answered these two questions with high variability, although most selected answers ≥4.

Concerning the *Clarity & simplicity* section, on average, the instructions provided to participants were clear enough to ensure their control during the FG; thus, they were able to contribute to the discussion at their best (Q6). Regarding *Flexibility*, it is interesting to observe that the participants believed the FG to be a flexible enough tool to address virtually any domain and any conceptual map; it is also important to note that FG applied to a conceptual map was deemed adequate to rectify mistakes (Qs 10 and 11).

The *Perceived role & collaboration* section also scored >4, underlining that the FG enabled participants to contribute (Qs 13, 14, and 15) to the CM and collaborative discussions (Qs 12, 16, and 17). The *Perceived effort* underlined that the FG was generally perceived long enough (with some notable exceptions, as underlined by Q18's SD and by the comment); it also highlighted that the FG was perceived as an activity requiring dedicated attention.

Regarding the *Experience*, most respondents already participated in a FG (information unknown to the analysts before the questionnaire administration). Moreover, the introductory part of the FGs received a markedly positive answer (Q21), as well as the adoption of CQs to guide the discussion (Q22). The positive results obtained for this answer may indicate the CQs have the potential to play a pivotal role in structuring and guiding FGs. Also, their use could potentially allow to refine the CQs, leveraging expert feedback, thus enhancing the quality of the *domain analysis* during OE.

Finally, the participants were generally *satisfied* with the FG experience, which could indicate that the answers provided were not biased by frustration or lack of interest (Qs 24 and 25).

4.2. Limitations of the study and future works

This study presents some limitations. First, the number of participants in both the FGs and the questionnaire does not allow to acquire enough data for generalizing the findings. More research and experiments with FGs should be conducted; also, the limited samples do not enable an understanding of whether the FGs' participants' number or the modality (in presence vs. online) impacted the evaluated metrics.

Therefore, it is worth investigating whether variables like FG's participant number and modality impact knowledge acquisition. Also, it would be worth investigating the possibility of including in the same FG experts on very different topics (and different and complex domains), to assess the mechanics of collaboration, knowledge acquisition, and modifications to the conceptual map.

5. Conclusions

This work investigated the role of FG as a knowledge elicitation tool during the domain analysis and conceptualization phase of OE. The underlying hypothesis – the FG is a collaborative tool capable of eliciting implicit knowledge and enabling the enhancement of a conceptual map – were confirmed by the qualitative and quantitative results. However, considering the limited number of FGs and the modest number of participants (and

questionnaire results collected), more experiments are required to allow the generalizability of the preliminary findings.

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