Requirements Analysis Skills: How to Train Practitioners?

Itzel Morales-Ramirez, Luis H. Alva-Martinez
INFOTEC, Av. San Fernando 37, 14050 Tlalpan, Mexico City. Email: {itzel.morales,luis.alva}@infotec.mx

***Abstract*—One of the goals of any software development organization (SDO) is the assurance of a high quality software. To achieve this, it is important to perform all the software related activities, especially those of the requirements engineering (RE) phase, in the right way and ideally by experts.**

However, the current practice reveals that this crucial phase is commonly performed by people with limited experience in RE, indeed, some of them ignoring the basic activities. We present a training plan in order to improve practitioners' RE analysis skills. The training plan was applied to 44 practitioners working at a Mexican SDO.

We developed such a plan based on the idea of considering six main dimensions that include theory, tests and mentoring sessions. The so called dimensions are: understanding the organization's domain, basic concepts of RE, requirements elicitation, requirements expression, requirements prioritization and requirements analysis.

In this paper, we present what are the topics discussed in each dimension, the feedback received by the practitioners after the training and how we envision the evolution of the training plan.

***Keywords*-Requirements engineering; RE Analysis skills; Training plan**

I. Introduction

It is well documented that an inadequate requirements analysis task leads to problems and a low rate of success in the projects [1]. One main factor that impacts a good requirements specification relies on having qualified people for doing such a task. To assure a high quality software, it is important to perform all the activities of the requirements engineering (RE) process in the right way, ideally, by RE experts. But, we find in practice there are different types of software development waste, and some of them are related to this crucial phase (i.e., RE) [2]. We refer to the type called "building the wrong feature or product", and this waste is caused mainly because the people in charge of doing this activity have limited experience in RE, they lack the knowledge about the mandatory activities or dismiss the importance of the process [3].

The identification of qualified people with the profile of a requirements engineer becomes a *must* that any company dedicated to develop software solutions should implement, in order to assure that they have the right people performing the analysis. There are some certifications in RE that would measure the level of knowledge of software engineers about the RE process, by means of theoretical questions, but to the best of our knowledge not all of them measure, specifically, their practical RE analysis skills [4].

It has been observed that those professionals who perform the activities of the RE process face difficulties in terms of: (a) not knowing how to begin the definition of a problem, (b) not knowing how to identify the requirements of the users; and (c) not knowing the corresponding process of analysis and specification of the requirements [5], [6].

We take the case of practitioners working at a Mexican software development organization (SDO) dedicated to sell software solutions that satisfy users' needs. This SDO employs software architects, software engineers, software analysts, test engineers and web designers, among other roles. Our research work presents a first attempt to train practitioners of a Mexican SDO, in order to improve their RE analysis skills that we believe are important during the actual practice of the requirements activities.

We have reviewed study plans from different sources, i.e. the literature (e.g., [5], [19]), certifications' preparation (e.g., BCS[1], IREB[2]), and observed required knowledge from the industry. We propose a plan for training the practitioners in six main RE dimensions, in order to develop or reinforce their RE analysis skills[3], such dimensions are: understanding the organization domain, basic concepts of RE, requirements elicitation, requirements expression, requirements prioritization and requirements analysis.

This plan is somehow related to Bloom's taxonomy [7], in such a way that the practitioners have to remember some concepts, understand a problem, apply their knowledge and propose solutions.

We applied a first version of the plan to 44 practitioners, and invested 40 hrs for mentoring sessions to give punctual feedback to the activities carried out by the practitioners. But, there were some restrictions to consider in our training plan interfering with the purpose of reinforcing practitioners' skills. For instance, the limited time of the practitioners to attend a face-to-face interaction; lack of knowledge about RE activities; lack of interest of some practitioners to study; no time for doing extra activities; and some practitioners working remotely.

In this paper, we present how the idea for the training comes up and what are the analysis skills we intend to be developed by the practitioners. The remainder of the paper is organized as follows. The related work is given in Section II.

[1]https://www.bcs.org/upload/pdf/resyllabus.pdf

[2]https://www.ireb.org/training/basics/

[3]We use the term *requirements analysis skills* as a meta term that involves all the skills identified in the six dimensions

Section III introduces the RE dimensions, the analysis skills associated to the dimensions, and how we implemented our plan to train the practitioners. The conclusion is given in Section V.

II. Related Work

The recognition of the importance of the requirements engineering (RE) process within the software development, is gradually making progress, but the requirements engineer position is just being acknowledged, as declared by Herrmann in [5]. In this work, it is clearly highlighted that RE must be performed by skilled experts, but companies still are not aware of advertising job positions requesting for the right skills. Some of the demanded RE competencies are for instance: modeling methods, RE tools, and experience in process analysis.

A work that was performed several years ago already stated that the advances of computing technology would imply more qualified people for specifics tasks [8]. Indeed, this work emphasises the need of investigating the required skills according to the changing needs of the industry.

1) Requirements Analysis Skills: It has been pointed out that there is a gap between the acquired knowledge and skills learned in the academia versus those required by the industry [9]. Due to this, there are research works aiming at evaluating technical skills of engineering graduates [10], [11]. For instance, the work described in [10] has been developed in Malaysia, the collection of data was through questionnaires in order to identify the required employability skills stated by employers. Some of the skills are for example: problem solving and decision-making skills, communication skills and knowledge of contemporary issues.

In the work of Ludi et al. [9] the authors used the Software Engineering Body of Knowledge (SWEBOK) [12] as a guide to assess the topics of the course "Introduction to Software Engineering" at Arizona State University. Part of the results of mapping the course to Bloom's taxonomy (the old version) and SWEBOK are presented for the requirements engineering phase, and it can be highlighted that "students have minimal knowledge of the skills and knowledge needed to work with stakeholders from their perspectives". This gives some evidence that academic courses do not provide enough foundation about requirements engineering practice.

Ahmed et al. [13] present an analysis of IT job advertisements in order to identify the most demanded soft skills by role. They found out that communication skills, analytical and problem-solving skills, and team player are in high demand for a system analyst. While for a software designer the communication skills and interpersonal skills are more important. For the roles of computer programmer and software tester the mainly required skills are: communication skills and in a moderate demand interpersonal skills, analytical and problem-solving skills, and organizational skills.

Another contribution on the comparison of 311 job ads about software analyst profiles (164 from Brazil and 147 from Mexico) is made by Calazans et al. [14]. They describe the competences in three dimensions (Knowledge, Skills and Attitudes). According to the results both countries demand professionals with formal and academic education. It was demonstrated that skills such as: the usage of techniques and tools, methodological competence, good written communication and good verbal communication have a high demand in both countries. It was not a surprise that analytical thinking, organization and information sharing were the most demanded attitudes that a requirements analyst vacancy requests in both countries.

2) Training professionals: Some organizations bet on training their professionals in architecture, programming languages and others topics, but there are few which opt for training them in requirements engineering. This is the case of Siemens, and there is a research work by Berenbach and Rayment [15] that evaluates the impact and benefits of training over 200 professionals in RE. After requesting the professionals to answer a questionnaire some of the conclusions are that the training is impacting positively since some of the professionals use the material learned regularly so that the industry gets benefits from technical training.

Colomo-Palacios et al. [16] identify competency levels for software engineers who want to pursue a professional career within software development companies of Spain. They elaborated a questionnaire and asked 50 professionals to define the competencies. Some of the technical competences are: software requirements, software design, software quality, software construction, and software testing.

The work by Nakatani et al. [17] presents the course design to teach senior engineers about requirements engineering, its importance and purpose. The target group of students are senior engineers with over ten years of experience and programming, design and team-work skills. As it can be observed, the analysis skill is not mentioned specifically, and the intention of the course is to motivate the students towards understanding the general skills required to successfully achieve the RE activities.

Although, the work presented by Luisa Mich [18] focuses mainly in teaching requirements analysis to students, she emphasises the lack of this skill and how business analysis and modeling skills are useful to represent a problem. This is an activity that must be very well understood by practitioners in order to solve real cases.

In this paper we present our idea for training practitioners on requirements analysis skills by giving them material and guidelines on how to perform it. This is our first attempt towards a regular plan for training practitioners.

III. Training practitioners on RE analysis skills

In order to prepare the material for the training plan we interviewed 10 practitioners, selected randomly (3 women[4] and 7 men). Each interview included a set of 16 questions that were asked mainly through Skype calls, with the objective of discovering what are, from their point of view, the observed dimensions worth to offer training and follow up of their activities.

Based on the received answers and what we have observed in practice (i.e., the finished projects), we defined six dimensions about Requirements Engineering that are needed to fully understand users' requirements. We visualize these dimensions as a cube, namely *RE's cube* (see Figure 1), as a metaphoric way of interpreting how is the cognitive process of the acquired practice and knowledge about RE.

Each dimension (face of the cube) implies a set of skills and required knowledge that are developed along the experience or training. These dimensions are: *understanding of the organization's domain*, *the elicitation of requirements*, *RE concepts*, *the expression of requirements*, *their analysis and prioritization*. Briefly, the dimension *understanding of the organization's domain* focuses on getting the knowledge of what is the core business process where a software system will operate. The *elicitation of requirements* emphasises the importance of using different techniques, either combining at the same time or at different times, in order to extract all the tacit knowledge from stakeholders. *RE concepts* is the dimension that concerns the basic knowledge about requirements engineering concepts, such as the process activities, types of requirements, and types of elicitation techniques.

The *expression of requirements* is the dimension that requests a practitioner to represent the requirements in different ways, such as: modelling or written expressions, in order to get validation from stakeholders. The last two dimensions are *analysis* and *prioritization of requirements*. *Requirements analysis* focuses on empowering the practitioner to decide when to perform a top-down analysis or a bottom-up analysis; while *Requirements prioritization* aims at reinforcing the need of requesting the stakeholders to collaborate with the practitioners to prioritize the requirements.

We believe that a practitioner, who is evolving through the journey of becoming an RE expert, is somehow solving the *RE's cube* at a different pace. Due to this belief, we have defined a training path composed of skills and knowledge to be developed. These skills and needed knowledge are taken from the following literature [5], [19], [20], [21], [6], [22], [10], [13], [14], [11], [23], certification's programs, such as IREB and BCS; and from the required skills established by the human resources (HR) department at our organization.

The selected skills and knowledge are briefly described in Table I, the first column lists the six dimensions, the second column contains the skills and the third column describes

[4]There were few women

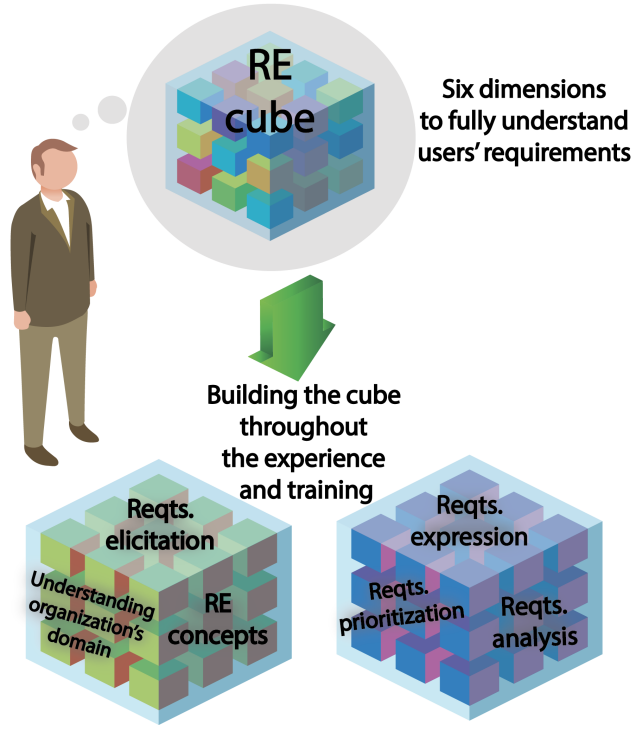

Figure 1. RE dimensions demanding a practitioner to develop *requirements analysis skills*

the knowledge. It is important to clarify that the skills that we have considered to be part of the dimensions are only a subset of what we found in the literature and what is required by HR. The rest of the skills are relevant as well, but we consider them as skills that must be transversal, example of such skills are: empathy, creativity, critical thinking, numerical knowledge, persuasiveness, technological knowledge, innovation, and planning.

From now on, we will call the skills listed in Table I as the *requirements analysis skills*, since we are focusing on the requirements phase and these skills are relevant to be evaluated in our industrial setting. Moreover, these skills are grouped into the six dimensions of our RE's cube, which we consider as needed to fully understand users' requirements. For example, we have found that the *conceptual representation* skill is a "must" for a software analyst and it's an industry's need, but many software analysts lack of it.

A. Strategy used for the training plan

At the time of the planning, the main question we were asking was: how are we going to train the practitioners? And for answering this question we needed to consider the following restrictions: 1) the limited time of the practitioners to attend a face-to-face interaction; 2) lack of knowledge about RE activities; 3) lack of interest of some practitioners to study; 4) no time for doing extra activities; and 5) some practitioners working remotely. Due to the explained

Table I
SET OF SKILLS PER DIMENSION OF THE RE'S CUBE

RE dimension	Skills	Knowledge
Understanding the organization's domain	-Global thinking -Problem solving -Initiative -Conceptual representation	-Knowledge to capture and understand the organization's domain -Knowledge about modeling the high level interaction between stakeholders and the system, with a context diagram -Knowledge about modeling the organization's processes to be automatized -Knowledge about modeling the business objects
Basic concepts of RE	-Continuous learning	-Knowledge about the basic terminology of requirements engineering (types of requirements, i.e. functional, non functional, business rules), the activities of the requirements definition process and basic techniques of extraction of requirements (ideas, desires, needs)
Requirements elicitation	-Verbal/written comprehension -Communication	-Knowledge about the creation of artefacts for interviewing / communicating with stakeholders -Knowledge about strategies to improve the flow of information
Requirements expression	-Conceptual representation -Process compliance -Abstraction	-Knowledge about the usage of standard notations for requirements representation -Knowledge about the techniques and methods of requirements engineering to represent / write the requirements (must ..., should ..., could ...)
Requirements prioritization	-Information management -Negotiation	-Knowledge about the different scales to prioritize the requirements together with the client and / or user (what the project includes, what is excluded)
Requirements analysis	-Conceptual representation -Process compliance -Abstraction	-Practical knowledge regarding the best approach while performing the analysis, i.e. a top-down or a bottom-up approach

restrictions, we decided to develop an online platform (using Moodle) in order to give flexibility to the practitioners to receive training in their free time. With this strategy we were tackling the restrictions: 1) limited time, and 5) remote work.

Besides the platform, we also stablished two days per week (Tuesday and Thursday), for having sessions with the practitioners, in order to support and guide them on their projects concerning specific points, for example how to model some diagrams (i.e., BPMN, state diagram). Each session had a duration of 2 hours (1 hour per practitioner), meaning we were attending at least 4 practitioners per week from June to July 2017, covering 32 hrs in total. With this strategy we were tackling the restrictions: 3) lack of interest and 4) no time for extra activities.

The reimained 8 hrs were assigned to give online feedback about the activities requested on the platform, attending questions and doubts regarding the online material (1 hr per week, mainly on Friday). With this strategy we were tackling the restrictions: 1) limited time; 2) lack of knowledge and 5) remote work.

The training plan includes activities somehow related to Bloom's taxonomy [7] in the form of presenting some theoretical concepts, then some questions or quizzes are presented. A scenario is described and the practitioner has to understand a problem, apply her/his knowledge by analyzing the problem and present some solutions.

In the following, we briefly describe the content of each dimension, as well as the mapping of the skills we believe can be evaluated:

1) ***Understanding the organization's domain****:* The purpose of this dimension is to improve the skills *Global thinking*, *Problem solving*, *Initiative* and *Conceptual representation* (see Table I), which a practitioner should posses, by asking her/him to solve a problem based on a scenario that describes a need and requests a system to solve the need. The scenario briefly explains some stakeholders and their needs, and presents a description of some functionalities that the system should be able to perform. The explanation of who are the stakeholders is not exhaustive, with the purpose of letting the practitioners to identify more stakeholders that would give some input to the system or receive some outputs.

Part of the theory makes reference to key concepts such as: domain, requirement, stakeholders, steps of the business analysis, organizational modeling, business process modeling and domain modeling.

2) ***Basic concepts of RE****:* The purpose of this dimension is to motivate the practitioners towards the skill *Continuous learning*. There are concepts that are presented and some questions to reinforce the learning. Example of types of concepts are: the different types of requirements, business rules; and questions to reinforce the learning are for instance a sentence "Specify the functionality of the software that the developers must create, so that the product will allow the users to complete their tasks". Four options are presented to the practitioners, so they can choose one to classify the previous sentence.

3) ***Requirements elicitation****:* This dimension has the purpose of improving the skills *Verbal/written comprehension* and *Communication*, in the sense of presenting different types of elicitation techniques such as: brainstorming, prototyping, storyboarding, modeling and the traditional interviews.

We asked the practitioners to implement some of the

elicitation techniques in their own projects, in order to put into practices the learning and present a series of tests.

4) ***Requirements expression****:* This dimension is totally focused on improving the skills *Conceptual representation* and *Process compliance*. For this part, we request to the practitioners to present the models that they create for their projects, using the standard modeling language of UML and BPMN. We asked them to upload the models and we give feedback or ask them to present their work personally in one session of one hour maximum. We revise the models present an adequate usage of the symbols and that validations are represented in the model.

5) ***Requirements prioritization****:* We believe that with this dimension we can improve the skill *Information management*. This management refers to a preliminary discrimination of information in order to highlight the core requirements. We present the practitioners the MoSCoW[5] technique and later we present an activity to prioritise some requirements based on that technique.

6) ***Requirements analysis****:* This last dimension aims at reinforcing the improvement of the skills *Conceptual representation*, *Process compliance* and *Abstraction*. In this part we asked the practitioners to present class diagrams, state diagrams, and activity diagrams developed in their projects.

IV. Observations

At the end of the training plan we identified that the RE dimensions with more difficulties for the practitioners are: *REConcepts*, *Elicitation* and *Prioritization*. The lack of knowledge, about strategies or techniques to communicate with stakeholders, makes the elicitation of requirements poorly performed. Sometimes without a complete knowledge that they can apply different tools in order to understand what the stakeholders need.

In addition to this, the practitioners were not applying an efficient way for prioritizing requirements. Some practitioners were not negotiating or discussing the requirements with the stakeholders, indeed, they were giving priorities to requirements that deal with the creation of catalogues or population of data, instead of focusing on the core functionalities of the software.

During the sessions we observed that skills such as global thinking, problem solving and initiative represent a high level of abstraction that needs to be expressed, and we found out that the practitioners have certain difficulties to "translate" this high level abstraction to specific modeling artefacts.

We discovered that the people with the role of software engineer and team leader got a good score on the skills conceptual representation and process compliance, specially the software engineers. This might be due to those roles have more expertise and are more familiarized in the usage of class diagrams (diagram requested), since they work with object-oriented programming.

In summary, it is a big challenge to make the practitioners aware that in the requirements engineering discipline the communication is crucial. They ignore sometimes the importance of the formulation of planned questionnaires, interviews and models, which are a mean to communicate, as well as the comprehension of all the information that is received by the stakeholders. We observed, for instance, that the practitioners did not read the instructions correctly or did not read carefully the given scenarios.

After the training was over, we sent an online questionnaire to the practitioners (with 5 questions), in order to get their feedback. Some feedbacks were requesting detail on each topic, for example: "I found the information very good, but it was the minimum of each topic and I would like it to be more detailed"; or opposite to this comment was the following feedback "I liked it, it's concrete and invites you to investigate more in the topics that are of interest."

V. Conclusions and Future work

In this paper we presented a training plan aiming at improving RE analysis skills of practitioners. We applied the plan with practitioners working at a Mexican SDO. Our plan includes a set of skills grouped in six RE dimensions, namely, understanding the organization domain, basic concepts of RE, requirements elicitation, requirements expression, requirements prioritization and requirements analysis. We found out that the skills that need further training refer to the dimensions *Elicitation* (skills: verbal/written comprehension, communication) and *Prioritization* (skills: information management and negotiation). Even though, there are some practitioners with many years of experience working empirically on the requirements analysis activities, we observed their lack of knowledge about the proper requirements engineering process. We used the Moodle platform as a supportive tool for the training, and it allowed us to reduce the impact of some restrictions, such as limited time of the practitioners for face-to-face interactions, and people working remotely. The personal sessions helped the practitioners solve specific doubts of their own projects, thus overcoming the restriction about not having time for extra activities. We will continue with coaching sessions to give a follow up of the progress of the practitioners in their projects, in order to correct deviations. Some of the improvements to our training plan include the addition of hours for personal sessions, and provide specific workshops on UML and BPMN.

Acknowledgment

We thank the participation of the practitioners that were involved in the training. We also thank Jorge L. Ramirez, Mayra Uscanga, Ebenezer H. Sanchez, and the reviewers for their feedback.

[5]https://en.wikipedia.org/wiki/MoSCoW_method

REFERENCES

[1] H. F. Hofmann and F. Lehner, "Requirements engineering as a success factor in software projects," *IEEE Softw.*, vol. 18, no. 4, pp. 58–66, Jul. 2001. [Online]. Available: http://dx.doi.org/10.1109/MS.2001.936219

[2] T. Sedano, P. Ralph, and C. Péraire, "Software development waste," in *Proceedings of the 39th International Conference on Software Engineering*, ser. ICSE '17. Piscataway, NJ, USA: IEEE Press, 2017, pp. 130–140. [Online]. Available: https://doi.org/10.1109/ICSE.2017.20

[3] D. M. Fernández, S. Wagner, M. Kalinowski, M. Felderer, P. Mafra, A. Vetrò, T. Conte, M.-T. Christiansson, D. Greer, C. Lassenius, T. Männistö, M. Nayabi, M. Oivo, B. Penzenstadler, D. Pfahl, R. Prikladnicki, G. Ruhe, A. Schekelmann, S. Sen, R. Spinola, A. Tuzcu, J. L. de la Vara, and R. Wieringa, "Naming the pain in requirements engineering," *Empirical Software Engineering*, vol. 22, no. 5, pp. 2298–2338, Oct 2017. [Online]. Available: https://doi.org/10.1007/s10664-016-9451-7

[4] Y. Sedelmaier and D. Landes, "How can we find out what makes a good requirements engineer in the age of digitalization?" *2017 IEEE Global Engineering Education Conference (EDUCON)*, pp. 230–238, 2017.

[5] A. Herrmann, "Requirements engineering in practice: There is no requirements engineer position," in *Requirements Engineering: Foundation for Software Quality - 19th International Working Conference, REFSQ 2013, Essen, Germany, April 8-11, 2013. Proceedings*, ser. Lecture Notes in Computer Science, J. Dörr and A. L. Opdahl, Eds., vol. 7830. Springer, 2013, pp. 347–361. [Online]. Available: http://dx.doi.org/10.1007/978-3-642-37422-7_25

[6] R. Klendauer, M. Berkovich, R. Gelvin, J. M. Leimeister, and H. Krcmar, "Towards a competency model for requirements analysts," *Information Systems Journal*, vol. 22, no. 6, pp. 475–503, 2012. [Online]. Available: http://dx.doi.org/10.1111/j.1365-2575.2011.00395.x

[7] E. J. Furst, "Bloom's taxonomy of educational objectives for the cognitive domain: Philosophical and educational issues," *Review of Educational Research*, vol. 51, no. 4, pp. 441–453, 1981. [Online]. Available: http://dx.doi.org/10.3102/00346543051004441

[8] D. M. S. Lee, E. M. Trauth, and D. Farwell, "Critical skills and knowledge requirements of is professionals: A joint academic/industry investigation," *MIS Quarterly*, vol. 19, no. 3, pp. 313–340, 1995. [Online]. Available: http://www.jstor.org/stable/249598

[9] S. Ludi and J. Collofello, "An analysis of the gap between the knowledge and skills learned in academic software engineering course projects and those required in real: projects," in *31st Annual Frontiers in Education Conference. Impact on Engineering and Science Education. Conference Proceedings (Cat. No.01CH37193)*, vol. 1, 2001, pp. T2D–8–T2D–11 vol.1.

[10] Y. M. Yusoff, M. Z. Omar, A. Zaharim, A. Mohamed, and N. Muhamad, "Formulation in evaluating the technical skills of engineering graduates," *Procedia - Social and Behavioral Sciences*, vol. 60, pp. 493 – 499, 2012, universiti Kebangsaan Malaysia Teaching and Learning Congress 2011, Volume II, December 17 20 2011, Pulau Pinang MALAYSIA. [Online]. Available: http://www.sciencedirect.com/science/article/pii/S1877042812038682

[11] C. S. Nair, A. Patil, and P. Mertova, "Re-engineering graduate skills a case study," *European Journal of Engineering Education*, vol. 34, no. 2, pp. 131–139, 2009. [Online]. Available: https://doi.org/10.1080/03043790902829281

[12] I. C. Society, P. Bourque, and R. E. Fairley, *Guide to the Software Engineering Body of Knowledge (SWEBOK(R)): Version 3.0*, 3rd ed. Los Alamitos, CA, USA: IEEE Computer Society Press, 2014.

[13] F. Ahmed, L. F. Capretz, and P. Campbell, "Evaluating the demand for soft skills in software development," *IT Professional*, vol. 14, no. 1, pp. 44–49, Jan 2012.

[14] A. T. S. Calazans, R. A. Paldes, E. T. S. Masson, I. S. Brito, K. F. Rezende, E. Braosi, and N. I. Pereira, "Software requirements analyst profile: A descriptive study of brazil and mexico," in *2017 IEEE 25th International Requirements Engineering Conference (RE)*, Sept 2017, pp. 204–212.

[15] B. Berenbach and T. Rayment, "The evaluation of a requirements engineering training program at siemens," in *2008 16th IEEE International Requirements Engineering Conference*, Sept 2008, pp. 205–210.

[16] R. Colomo-Palacios, E. Tovar-Caro, A. García-Crespo, and J. M. Gómez-Berbís, "Identifying technical competences of it professionals: The case of software engineers," *Int. J. Hum. Cap. Inf. Technol. Prof.*, vol. 1, no. 1, pp. 31–43, Jan. 2010. [Online]. Available: http://dx.doi.org/10.4018/jhcitp.2010091103

[17] T. Nakatani, T. Tsumaki, and T. Tamai, "Requirements engineering education for senior engineers: Course design and its evaluation," in *2010 5th International Workshop on Requirements Engineering Education and Training*, Sept 2010, pp. 26–35.

[18] L. Mich, "Teaching requirements analysis: A student project framework to bridge the gap between business analysis and software engineering," in *Proceedings of the 8th Intl. Workshop on Requirements Engineering Education & Training co-located with 22nd International Conference on Requirements Engineering (RE 2014), Karlskrona, Sweden, August 25, 2014.*, ser. CEUR Workshop Proceedings, B. Penzenstadler, S. Gregory, and D. Landes, Eds., vol. 1217. CEUR-WS.org, 2014, pp. 20–25. [Online]. Available: http://ceur-ws.org/Vol-1217/paper3.pdf

[19] K. Pohl and C. Rupp, *Requirements Engineering Fundamentals: A Study Guide for the Certified Professional for Requirements Engineering Exam - Foundation Level - IREB Compliant*, 1st ed. Rocky Nook, 2011.

[20] K. E. Wiegers, "So you want to be a requirements analyst," *Originally published in Software Development*, vol. 11, no. 7, 2003.

[21] D. Zowghi and S. Paryani, "Teaching requirements engineering through role playing: Lessons learnt," in *Proceedings of the 11th IEEE International Conference on Requirements Engineering*, ser. RE '03. Washington, DC, USA: IEEE Computer Society, 2003, pp. 233–. [Online]. Available: http://dl.acm.org/citation.cfm?id=942807.943928

[22] B. Al-Ani and S. E. Sim, "So, you think you are a requirements engineer?" in *14th IEEE International Requirements Engineering Conference (RE'06)*, Sept 2006, pp. 337–338.

[23] I. C. S. Staff, *Software Engineering Competency Model (SWECOM): Version 1.0*. IEEE Computer Society Press, 2014.