Software Process Education Oriented to Software Industry Needs

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Abstract

Typically, software professionals are trained in undergraduate courses as a way of preparing to the industry. However, there is a shortage of qualified professionals in relation to Software Process field in the Brazilian industry. Thus, software companies have to provide skills related to the Software Process areas through training. To address this problem, this PhD research aims to analyze the recommendations for the Software Process education in curriculum guidelines of computer courses in Brazil. In addition, we will examine which of these recommendations are relevant to software professionals. Furthermore, we propose a teaching approach that aims to meet the goals of these curriculum guidelines through models and quality standards for the process and software product widely adopted in the Brazilian software industry.

1. Motivation

The Software Engineering (SE) teaching is one of the topics of greatest importance in courses in the field of computing [Iee14]. This arises from both the relevance of the software itself, which has a strategic role in modern society, and the challenges related to the complete formation of a professional who will work in companies that consume or produce information technology resources. The result is an increase in demand well-qualified SE professionals in the software industry [Dul03]. It believed that, in the future, all general-purpose software will constructed by a software engineer [Nun10], because is a matter of obtain quality and reliability of the developed software product.

1.1 Gap Area

Bachelors of computer courses working as software professionals in Brazil learn more about Software Process topics after undergraduate study because the necessary skills are not adequately addressed in graduate [Wan09]. The Brazilian software industry presents a shortage of suitably qualified professionals to work in professions that involve stages of the software development process, encompassed by SE [Abe14].

The root of the problem may be in the training of these professionals, i.e., the approach adopted for the teaching of Software Process during undergraduate education. Several authors have reported difficulties found in the teaching of SE, as Soares [Soa04], Castro, Gimenes, and Maldonado [Cas00], and Hazzan and Dubinsky [Haz03]: (i) too much content being given in a short time; (ii) low motivation that the students have to study the theoretical concepts of SE; (iii) difficulties in preparing students for professional practice within academic environments.

1.2 Research Scope

According to the ACM/IEEE [Acm13], SE is a discipline concerned with the application of theory, knowledge and practice for the effective and efficient development of software systems that meet user's requirements. To fulfill the users' needs, SE professionals must to ensure deadlines, costs, and quality of the product developed. However, defining a software process is not a trivial activity, especially when the objective is to ensure high quality products and a competitive level of productivity [Mac05].

In order to meet customer requirements, with respect to the product generated, the industry has adopted the ISO/IEC 25000 standard [Iso14], which specifies quality attributes that monitor throughout the software development process [Mac05]. Regarding the quality of the development process, the Brazilian software industry has followed several reference models, such as CMMI-DEV [Cmm10] and MR-MPS-SW [Sof12], which define processes areas that comprise maturity and capacity profiles.

Thus, this PhD research will examine the recommendations for the teaching of Software Process available in the curriculum guidelines of computer courses in Brazil, more specifically with regard to the software process area. This analysis aims to obtain qualitative data about: (i) teaching and learning of

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software process from teaching approaches applied in undergraduate computer courses; and (ii) the knowledge about software process, considered necessary, for professionals in this area. The results of this analysis will used to define a new teaching approach that aims to meet the goals of these curriculum guidelines through quality models and standards widely adopted in the software industry to define and improve software process.

2 Problem Statement and Related Work

We can classify the problems of this PhD research (Research Problems - RP) in three groups. (RP-I) First, there is a need to analyze in detail the curriculum guidelines of undergraduate computer courses in Brazil, in order to identify which the software process activities are contemplated. After that, there is the need to analyze how these curricular recommendations are being implemented in Brazilian computer courses to identify the teaching approaches adopted by teachers of SE. (RP-II) Subsequently, there is a need to investigate what activities are actually relevant to SE professionals to define your software process. (RP-III) Furthermore, we will investigate the correlation between activities of process and quality characteristics of software product. The aim is to analyze what activities affect certain characteristics of product quality.

2.1 Problems Area

SE professionals working in the industry have dissatisfaction regarding the level of preparedness of recently graduated students entering the job market [Let07] [Hil07]. Software companies have to complement the knowledge of recent graduates with training and have to provide technical and non-technical skills related to the software development process [Bes12].

According to Lethbridge, Diaz-Herrera, LeBlanc, and Thompson [Let07], this deficiency in the formation of graduates in the SE area is the result of an inadequate education. This finding may be reinforced by the research done by Sargent [Sar04], which reveals that: (i) only 40% of IT professionals in the United States have training in this area; (ii) 40% of those are aware of the main fields of SE, such as requirements, architecture, testing, human factors, and project management.

Although we did not find statistical data in relation to Brazil, it believe that the reality of SE professionals in this country should not be different, given the scenario observed by the authors of this paper on numerous consulting assignments involving the implementation of Software Process Improvement.

2.2 Limitations of Related Work

There are several works dealing with teaching SE approaches [Nun10] [Cas00] [Kit07] [Kit08]. However, these studies do not directly address RP-I. So far, all identified studies that relate to RP-I tend to perform a restricted analysis, focusing primarily on proposing teaching approaches for a particular institution without examining the main curriculum guidelines of the area.

Unlike these works, this research will cover the main curriculum guidelines of the computing area [Acm13] [Sbc05] [Mec03]. In addition, we will conduct an empirical study about the teaching approaches adopted by teachers in applying the Software Process topics proposed in these curriculum guidelines.

Regarding the RP-II, there are few studies that investigate the relevance of process activities to SE professionals [Wan09] [Soa04] [Let07]. From these studies results, it is not possible to state if the problem is in the recommendations of curriculum guidelines, or in the SE teaching approaches.

Differently from these works, besides consulting the SE professionals' opinions about the relevant topics of software process, this PhD research will consider the teaching approaches used by the teachers and their effectiveness by consulting the students of these disciplines.

Finally, among the problems of RP-III, we intend to investigate the correlation between process activities and quality characteristics of the software product. Maciel [Mac05] does a mapping between the process activities contained in the ISO/IEC 12207 and ISO/IEC 15504 standards, and the product quality characteristics from the ISO/IEC 9126. However, the ISO/IEC 9126 standard is outdated. This PhD research will consider in its correlation analysis the product quality characteristics from the predecessor of the ISO/IEC 9126 standard, the ISO/IEC 25000 [Iso14].

3 Questions and Hypotheses

Our main goal is to propose an approach based on quality standards widely adopted in the software industry in order to support the teaching and learning

of Software Process in computer courses. In this context, we define our research questions as follows.

RQ1. *What are the Software Process topics covered in the curriculum guidelines of the computer courses?*

RQ2. *What are the Software Process topics covered in computer courses curricula?*

RQ3. *What are the Software Process topics effectively learned by computer students?*

RQ4. *What are the Software Process skills required by the software industry and which of them were acquired in the computer courses?*

We defined our research questions to try refuting the following null hypothesis:

H0. *The current approaches to teaching Software Process meets the software industry needs.*

If the null hypothesis is refuted, we intend to test our alternative hypothesis:

H1. *The current approaches to teaching Software Process does not meet the software industry needs due to misalignment between the curriculum of Software Engineering discipline and the real industry needs.*

The research methods used to answer the research questions and to test H0 and H1 will presented in the next section.

4 Research Method and Progress

In order to answer our research questions, first we are conducting some exploratory studies to understand the curriculum guidelines proposed by ACM/IEEE [Acm13], the Brazilian Computer Society (SBC) [Sbc05] and the Brazilian Ministry of Education (MEC) [Mec03].

Subsequently, we have to address the problems that arise in applying these curriculum guidelines in undergraduate courses. These approaches will analyzed in order to identify strengths and weaknesses. This analysis, as well as the surveys conducted with teachers, students, and industry professionals, will be inputs to the definition of an approach oriented to product and process quality profiles. This profile represents the set of characteristics/process areas that be refined and institutionalized in the organizational environment. The process profile will based on the CMMI-DEV [Cmm10] and MR-MPS-SW [Sof12] quality models and the product profile will based on ISO/IEC 25000 [Iso14]. We chose these models and standards because of their wide acceptance in the efforts of the Brazilian software industry in obtaining quality in software development. For example, the Brazilian MR-MPS-SW model was officially deploying 593 companies in Brazil[1]. In addition, the international CMMI-DEV model was officially implanted in 203 Brazilian companies[2].

4.1 Identifying Process Activities Included in Computer Courses

To answer RQ1, we will conduct a literature review in the curriculum guidelines from ACM/IEEE [Acm13], SBC [Sbc05] and MEC [Mec03] aiming to identify which Software Process topics are contemplated in these guidelines. The results of this review may support (or refute) the hypothesis H0, giving us evidence that the process activities suggested in the curriculum guidelines meet (or not) the software industry demands.

Then, in order to answer RQ2, a survey (S-I) will be conducted with the teachers of undergraduate Computer Science courses. The goal of this survey is to analyze which process activities identified in the literature review are included in the SE curricula disciplines. These results may validate the H0 hypothesis. If this confirmed, the problem may be in the curricula adopted in the SE disciplines.

Finally, answering RQ3, a survey (S-II) will be conducted with students that concluded the Software Engineering discipline. The aim of this survey is to assess whether the students are learning the process activities contemplated in SE disciplines. The results of S-II can validate H0 too, giving us, evidence that the problem may be in the teaching approaches adopted in the classrooms. We are currently working on this phase of the research.

Both S-I and S-II will be applied to undergraduate Computer Science courses from public and private universities in Brazil and will follow the guidelines of Kitchenham and Pfleeger [Kit08].

4.2 Identifying Process Activities Relevant for the Software Industry

To answer RQ4, our goal is, through a survey (S-III), to consult industry professionals about which of their skills to perform process activities were acquired during undergraduate study. In this survey, the goal is

[1] http://www.softex.br/mpsbr/, accessed in May 2015.

[2] http://cmmiinstitute.com/, accessed in May 2015.

to find information on the relevance of the topics covered in the SE disciplines according to the opinion of professionals in this area. The results of S-III can refute the H0, giving us evidence that the process activities suggested in curriculum guidelines dot meet the software industry demands reported by industry professionals. In this way, we can work on validation of H1.

S-III will applied in public and private software companies in Brazil and will follow the guidelines of Kitchenham and Pfleeger [Kit08].

4.3 Defining an Approach to Teaching Software Process Oriented to Quality Standards

After conducting exploratory studies for answering the four research questions, we will obtain: (i) the recommendations of curriculum guidelines; the teaching approaches of SE teachers; and (ii) the considerations of students and industry professionals. These results will considered in the definition of the teaching approach proposed by this research.

Additionally, we plan to conduct a systematic mapping of the relationship between the SE practices recommended by the CMMI-DEV [Cmm10] and MR-MPS-SW [Sof12] models and the practices contained in ISO/IEC 25000 [Iso14] product quality standard. This systematic mapping will follow the guidelines of Kitchenham and Charters [Kit07]. Based on the understanding of this relationship, it will be possible to integrate the concepts of process maturity and capability profiles, and product quality, which will be the basis of the methodology that will compose the teaching approach proposed in this PhD research.

The teaching approach will adopt the Problem Based Learning educational method that uses problems to initiate, motivate, and focus the knowledge acquisition, and to encourage the development of skills and attitudes in students that will be useful in a professional context [Bes12].

In order to validate our proposed teaching approach, we plan to conduct a controlled experiment in an SE discipline in an undergraduate Computer Science course. This experiment will follow the guidelines proposed by Wohlin [Woh00].

5 Expected Contributions and Partial Results

In summary, our PhD research is intended to: (i) identify process activities and analyze their relevance for the software industry; (ii) improve the understanding of curriculum guidelines of the SE disciplines through the analysis of these curricula; (iii) identify the potential problems in the approaches to teaching Software Process through the analysis of the implementation of curriculum guidelines; and (iv) furthermore, provide an educational approach to meet the training demands of SE professionals during undergraduate study.

The three surveys (S-I, S-II and S-III) are being applied in undergraduate computing of public and private universities in Brazil. These surveys are releasing in e-mail list, SE groups on social networks and in loco on public and private universities. The surveys is available in http://goo.gl/vn5jHS and the survey protocol is available in http://goo.gl/gqzMrP. By the time, we have obtained 42 responses.

Finally, we intend to publish the results to stimulate replication of this type of research and hence solve the gaps of the teaching SE area. In this context, we emphasize that the proper SE education is important to improve the current state of software development and help mitigate many of the traditional problems associated with the software industry.

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