Poster: A Methodology to Teaching Statistical Process Control for Software Engineers: An Overview

Julio Furtado and Sandro Oliveira

July 20, 2018

A Methodology to Teaching Statistical Process Control for Software Engineers

Julio Cezar Costa Furtado
Department of Exact and Technological Sciences
Federal University of Amapá
Macapá, Amapá, Brazil
furtado@unifap.br

Sandro Ronaldo Bezerra Oliveira
Graduate Program in Computer Science
Federal University of Pará
Belém, Pará, Brazil
srbo@ufpa.br

ABSTRACT

The Statistical Process Control (SPC) importance for the software industry has grown in recent years, mainly due to the use of quality models. In this context, this work aims to propose a teaching methodology for SPC where the learning process is student centered. The methodology is composed of reading experience reports, PBL, practical cases discussion, use of games, practical projects, and reflections on the learned.

CCS CONCEPTS

• **Social and professional topics~Model curricula**

KEYWORDS

Statistical process control, software engineering education, teaching methodology, computer course.

1 INTRODUCTION

A process considered in statistical control must be stable and repeatable. However, the SPC use in software development organizations has been showed complex [1]. This difficulty may also be caused by the type of training of these professionals, in the approach used for teaching SPC during the graduation of these students, and if SPC topics were at least taught. The [2, 3] works identify situations that have too much content to teach in a short time, low motivation of students and difficulties in preparing students to professional practice within the academic environment.

2 THE TEACHING METHODOLOGY

A previous work has identified 13 basic skills needed for a software engineer to work in SPC [4]. With these skills identified, it was possible to define the discipline syllabus necessary to provide all this background. The discipline was divided into 4 units: (1) **Business processes and objectives**, (2) **Measurement**, (3) **Statistical control**, and (4) **Capacity and process improvement evaluation**. Table 1 summarizes the contents that will be taught in each unit and what results are expected in relation to the skills acquired by the students. For each item, it was also detailed the expected level of cognitive ability, using a terminology based on Bloom's taxonomy [5] that consists in remembering, understanding and application. It is important to emphasize that Apply includes Understand that includes Remember [6].

The selection of techniques, methods and teaching resources adopted in this methodology was based in [7] that aims to enhance the joint adoption of these items, through an iterative cycle to meet the different learning profiles. The education model of Portela [7] is based on the learning cycle of Kolb [8] and on the iterative teaching methodology proposed in [9].

Table 1: Discipline Syllabus and Goals

Topics	Expected Results	Level
1.1 Introduction to processes	The student must know the basic concepts and representation of processes.	Remember
	The student must be able to see the relationship between the quality of the process and the quality of the product.	Remember
1.2 Processes and organizational structure	The student must be able to see the relationship between the process and the organizational structure.	Remember
1.3 Definition and implementation of processes	The student must understand the analysis and modeling of processes.	Understand
	The student must know the management of the processes implementation.	Remember
1.4 Critical processes for the business	The student must be able to identify and select (under supervision) the critical processes of an organization.	Apply
2.1 Measurement concepts	The student must know the basics of software metering.	Remember
	The student must be able to understand how measurement objectives should support the organization's objectives.	Remember
2.2 Measurement process	The student must be able to define and execute (under supervision) a measurement plan.	Understand and Apply
3.1 Introduction to Statistical Control	The student must be aware of the importance of statistical control.	Remember
3.2 Control charts	The student must understand the various types of control charts.	Understand
	The student must be able to select the control charts that best suit a situation.	Apply
3.3 Cause and effect assessment	The student must be able to evaluate the measurement data and identify the special causes of process variation and the effects they could cause.	Understand and Apply
4.1 Assessment of process capability	The student must be able to characterize the performance of a process.	Apply
	The student must be able to establish performance models for the process.	Apply
4.2 Improve of process performance	The student must be able to propose adjustments and improvements to the process performance models	Apply

Therefore, each of the 4 units of the discipline are composed of 6 stages: **Initiation**, the study of each unit begins from the identification of a problem; **Preparation**, this stage is executed by the students parallel to all stages and in an extra class way. In it, the student will study the material provided by the professor (videotapes, articles, and books) to understand the topics. **Discussion**, this stage consists of a traditional class held by the professor followed by a discussion about the subject; **Practice**, students practice the knowledge gained using games to internalize and develop the skills; **Contextualization**, students will now undertake a practical project to integrate all skills acquired during the unit; and **Reflection**, the final step consists of the students presenting the results obtained in the practical project and reflecting on the experience.

The way these steps will be reflected in the teaching strategy of each unit is defined according to the level of learning intended for the topic, where: topics with the expected level of Remember will be attended by the Discussion stage; topics listed as Understand require the Practice step to be accomplished; and topics where the student is expected to reach the Apply level will be covered in the Contextualization stage. Emphasizing that each unit goes through all the stages of the cycle.

4.1 Play Activities and Practical Projects Used

For each topic with the Remember or Apply level of learning, a game and / or a practical project.

To contemplate the topic 1.3 a ludic activity focused on the modeling and redesign of the process is carried out. They receive the requirements and develop a prototype, then begin the first building cycle without the use of any process. Then they are asked to define a process for building the aircraft and the second building cycle begins. At the end, the results obtained between the two cycles are compared and they are asked to think of improvements for the process used.

The topic 1.4 was reached through a practical project where students are responsible for identifying critical processes in a factory. After the context briefing, students are organized into pairs and receive the organization's process list along with an interview with clients informing them about the most important quality criteria. Students then relate this information and use the Quality Function Deployment (QFD) method applied to identify the critical processes of this organization. At the end, students should present the results and answer the final questions of the reflection stage.

For the topic 2.2 two activities are performed. A more playful activity to internalize Goal-Question-Metric (GQM) concepts by developing the GQM for everyday purposes. And practical project where students define and execute a measurement, where students receive the context of a software company that aims to increase the number of clients served. For the students to be able to carry out all these activities, the organization's software development process and the measures that were collected in the company's projects are provided. At the end, students should present the results and answer the final questions of the reflection stage.

For the topic 3.2 a play activity is performed with dices, based on [10]. The goal is to teach the use of control charts through the data collected on several rolls of two dices. Students are organized in pairs and are asked to make 10 collections of 5 rolls with the given pair of dices. Then, the values are recorded in a worksheet and a chart is plotted. It is then asking if it is possible to improve the variation obtained and what should be done for it. At the end, the students compare the two charts generated and are asked about what and why it happened.

For the topic 3.3 a practical project is carried out that introduces students to the context of a factory that is seeking to statistically control its building process. Students then receive two sets of data and are informed that they were collected daily. Based on these data, students must choose and justify what are the best control charts for the situation. At the end, students must present the results and answer the final questions of the reflection stage.

The topic 4.1 is addressed through a practical project where students are exposed to the context of a football team and their game history in two seasons of a championship. Students should then assemble baselines for the number of points gained per round, for the goal balance per round, and for the number of hours trained per round. At this point, they will be informed about what the expected club board of the team's behavior in the field. Based on this information, students check whether the process is capable or not. Students are then asked to establish a performance model for the next season. At the end, students should present the results and answer the final questions of the reflection stage.

Finally, in the topic 4.2 students also undertake a practical project where they receive a process and the baseline of performance that is not stable. Based on context and observations, they should be able to assess the special causes and remove them. At this point, the professor questions about the possibility of continuing to improve the process continuously. At the end, students should present the results and answer the final questions of the reflection stage.

5 CONCLUSIONS

This work proposed a teaching methodology for SPC where the learning process is student centered. With this work, we hope to help strengthen ties between academia and industry and to provide professionals more adapted to these organizations.

REFERENCES

[1] C. Fernández-Corrales, M. Jenkins, and J. Villegas, "Application of Statistical Process Control to Software Defect Metrics: An Industry Experience Report", in: 2013 ACM/IEEE International Symposium on Empirical Software Engineering and Measurement, pp. 323-331, 2013.

[2] J. Castro, I. Gimenes, and J. Maldonado, "A proposal for pedagogical plan for the Software Engineering discipline", II quality course of undergraduate of Computing and Informatics area, Curitiba, Brazil, pp. 251-270, 2000.

[3] O. Hazzan and Y. Dubinsky, "Teaching a software development methodology: The case of Extreme Programming", 16th Conference on Software Engineering Education and Training, Madrid, Spain, pp. 176-184, 2003.

[4] J. Furtado and S. Oliveira, "A study on perception of the usefulness of statistical process control in software development organizations: an application of survey". 14º CONTECSI, Brazil, 2017.

[5] Bloom. "Taxonomy of Educational Objectives: The Classification of Educational Goals". Handbook I, Cognitive Domain: Longmans, 1956.

[6] D. J. Nunes, M. H. Yamaguti, and I. Nunes. "Refinement of student competences of the software engineering course". IX Forum on Education in Software Engineering, p. 143-146, 2016.

[7] C. S. Portela, A. Vasconcelos, and S. Oliveira. "FRAMES: A framework to teaching-learning the software engineering topics in ACM/IEEE and SBC curricula". IX Forum on Education in Software Engineering, Brazil, 2016.

[8] D. Kolb. "Experiential Learning: Experience as the Source of Learning and Development". NJ: Prentice-Hall, 1984.

[9] K. Gary, T. Lindquist, S. Bansal, and A. Ghazarian, "A Project Spine for Software Engineering Curricular Design". In Proceedings of 26th Conference on Software Engineering Education and Training (CSEET), pp. 299-303, 2013.

[10] M. P. Jones, R. S. Hawkins, and R. Smith, "Enhancing student understanding of Control Charts using a dice activity", The Technology Interface, Spring, 2008.