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Are learning styles useful indicators to discover how students use Scrum for the first time?

Ezequiel Scott, Guillermo Rodríguez, Álvaro Soria *, Marcelo Campo

ISISTAN Research Institute (CONICET-UNICEN), Campus Universitario, Paraje Arroyo Seco, Tandil, Buenos Aires, Argentina

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ABSTRACT

Teaching agile practices is in the cutting-edge of Software Engineering education since agile methodologies are widely used in the industry. An effective strategy to teach agile practices is the use of a capstone project, in which students develop requirements following an agile methodology. To improve students' learning experience, professors have to keep track and analyze the information generated by the students during the capstone project development. The problem here arises from the large amount of information generated in the learning process, which hinders professors to meet each student's learning profile. Particularly, to know the students skills and preferences are key aspects on a learner-centered approach of education in order to personalize the teaching. In this work, we aim to discover the relationships between students' performance along a Scrum-based capstone project and their learning style according to the Felder–Silverman model, towards a first step to build the profiles. To address this issue, we mined association rules from the interaction of 33 Software Engineering students with *Virtual Scrum*, a tool that supports the development of the capstone project in the course. In the present work we describe promising results in experiments with a case-study.

1. Introduction

The adoption of agile methodologies for software development has increased for the last few years. In particular, several surveys carried out by companies, as well as scientific evidence (Ambler, 2006; Hossain, Babar, & young Paik, 2009; Paasivaara, Durasiewicz, & Lassenius, 2009; Salo & Abrahamsson, 2008), has revealed that Scrum is one of the most used frameworks in software development industry because of its potential improvements in productivity, quality, and client satisfaction. In line with industry, academia also has focused on teaching agile practices, leading Scrum to become the cutting-edge of Software Engineering education as an effective strategy to prepare students for facing challenges in professional contexts (Chookittikul, Kourik, & Maher, 2011; Devedzic & Milenkovic, 2011; Mahnic, 2010; Melnik & Maurer, 2003).

A widespread adopted strategy to teach agile practices is the use of capstone projects (Devedzic & Milenkovic, 2011; Mahnic, 2010; Mahnic & Rozanc, 2012; Schroeder, Klarl, Mayer, & Kroiss, 2012). In this kind of courses, professors make emphasis on the experience acquired by students, who are motivated to tackle real problems rather than resolve traditional exercises or tests. Students are divided into groups and are given a list of requirements (also called User Stories in the Scrum jargon) to develop a software product, whereas professors train students in skills related to problem solving, communication and project management. Therefore, capstone projects allow students to put Scrum into practice in a quasi-real controlled environment, in which the students synchronize the team-work, communicate problems and challenges and assess the quality of the resulting product through testing and validation activities. To support these activities, students are encouraged to interact with a development environment, in the same way that development teams do in the industry (Azizyan, Magarian, & Kajko-Matsson, 2011). Most of the surveyed companies that apply Scrum also use support tools to manage, test and monitor projects, since they can be a rich source of information to extract metrics and diagnosis about projects, processes and teams (Hartmann & Dymond, 2006).

In order to help students to interact with the development environment, given that they learn in many ways, professors tend to personalize the teaching by means of learner-centered principles. Thus, professors should detect the profiles of their students, the way in which they learn, their strengths and weaknesses (Dick, Carey, & Carey, 2005; McCombs & Whisler, 1997). For instance, the professor should monitor the student's performance with

* Corresponding author. Tel.: +54 2409442224553.
E-mail addresses: ezequiel.scott@isistan.unicen.edu.ar (E. Scott), guillermo.rodriguez@isistan.unicen.edu.ar (G. Rodríguez), alvaro.soria@isistan.unicen.edu.ar (Á. Soria), marcelo.campo@isistan.unicen.edu.ar (M. Campo).

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Scrum by analyzing the artifacts generated, the feedback provided, and their interaction with development tools. However, the large amount of information resulting from the capstone project may prevent professors from achieving their goals (Antunes, 2010). Thus, there is a need of exploring new approaches that allow professors to bear in mind the students' different ways of learning easily.

In this context, learning styles arise as useful indicators as they are defined as the characteristic cognitive, affective, and psychological behavior that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment (Keefe, 1988). Many studies report that the usage of learning styles in teaching is an important factor that can improve the quality of education (Felder & Spurlin, 2005; Hawk & Shah, 2007). Among these studies, Layman, Cornwell, and Williams (2006) propose an assessment of the didactic based on learning styles and the personality types. Others (Graf & Liu, 2010; Limongelli, Sciarrone, & Vaste, 2008; Popescu, 2009; Zaina, Bressan, Rodrigues, & Cardieri, 2011) focus on applying learning styles to learning environments, such as web based environments. Thus, there is an increasing interest in analyzing the students' behavior by considering their learning preferences. Out of the learning style models, we use the Felder–Silverman Learning Style Model (FSLSM) (Felder & Silverman, 1988) since it has been widely applied in engineering education and research related to learning technologies (Kuljis & Liu, 2005).

In this work, we formulate the hypothesis that there is a relationship between the way students perform Scrum practices along a capstone project and the students' learning style according to FSLSM. On the one hand, the Scrum practices under study are the definition and specification of user stories, estimation of user stories by means of *Planning Poker*, and tracking of user stories, among others. On the other hand, FSLSM comprises four dimensions that contribute to explain the preferences that students have when they receive and process information: *perception*, *processing*, *understanding* and *input*. *Perception* relates to the type of information a student prefers to perceive; *processing* describes how perceived information is converted into knowledge; *understanding* describes the way students' progress towards understanding; finally, *input* considers the way in which students prefer to receive external information.

In this context, the first step is to know students' learning styles, which are gathered from the Index of Learning Style (ILS) (Felder & Spurlin, 2005) based on FSLSM. Then, our approach focuses on tracking students' interaction with *Virtual Scrum* (Rodriguez, Soria, & Campo, 2013), a tool that supports the Scrum process and tracks off students' prioritization and estimates of user stories, and time spent on tasks along the capstone project. To discover relationships, we mine the students' interaction log along with their learning style by applying association rules so as to show the frequency between the way in that students perform the agile practices and different styles.

To corroborate our hypothesis, we carried out an analysis of the behavior of 33 students from a Software Engineering course during 2011 at Universidad Nacional del Centro de la Provincia de Buenos Aires (UNICEN). The experimental results show there is a considerable correlation between the students' behavior when they use Scrum for the first time and their learning styles according to de FSLSM; supported by a confidence of 86.75%, a support of 22.50% and lift of 1.44, on average for the association rules.

The remaining of this paper is organized as follows. Section 2 introduces the background topics in the area of Scrum and learning styles, and also reports on related works. Section 3 presents our approach to discover the relationship between students' learning style and their performance along the capstone project. In Section 4, the results obtained from the experiments, as well as lessons learned and threats to validity, are presented. Finally, in Section 5, we state our conclusion and discuss future lines of work.

2. Background

Due to the current trend of using Scrum in the software development industry, universities have begun to teach Scrum in Software Engineering courses. Many studies have shown promising results when professors include teaching strategies that enhance students' comprehension of agile practices (Reichlmayr, 2003; Rico & Sayani, 2009). Recently, the use of capstone projects based on Scrum has been adopted as a vehicle for teaching the basic concepts in software engineering. This kind of project is developed in the classroom and supervised by professors; this strategy aims to increase student's participation in the learning process and address not only common problems found in the development of software systems but also several values proposed by the Agile Manifesto (Beck et al., 2001). Mahnic (2012) reports an experience of teaching Scrum using capstone projects in a Software Engineering course. The author identifies both the students' behavior and their perception of Scrum when performing activities, and proposes recommendations to achieve a successful capstone project; furthermore, even the behavior of students using Scrum for the first time has been observed. In the same line, Zualkernan, Al Darmaki, and Shouman (2008) proposes a simulation model in order to analyze deviations from the Scrum development process. Then, students are shown the explanations of the deviations so that they can enhance their conceptual learning of Scrum. Other authors, such as Devedzic and Milenkovic (2011), recommend some practices that are the result of the use of both Scrum and Extreme Programming (XP). These practices facilitate the adoption of the methodology and allow students to avoid several problems.

Most of the works mentioned above agree with the idea that the individual characteristics of students affect their performance in the agile development process. However, they fail to obtain evidence of how students behave toward their first contact with Scrum according to their learning preferences. This is mainly due to the omission of strategies that allow for the analysis of students' interaction with software development tools in the Scrum course. In this context, several approaches have shed light on the way students learn by considering their individual characteristics. For instance, Kay (2010) have proposed the identification of behavioral patterns from a group of students that used Extreme Programming. These patterns are oriented to groups instead of individuals. Similarly, Talavera and Gaudioso (2004) have identified patterns using data mining; however, this approach has attempted to build collaborative user profiles. Our work differs in that the analysis is focused on each student's learning styles to obtain individual preferences. Along this line, Prata et al. (2009) have detected a relationship between interpersonal conflicts and how they arise inside the course; Barros and Verdejo (2000), with the DEGREE system, have analyzed students' interaction processes from their text manipulation. However, these works fail to analyze behavior from the students' learning styles point of view. Thus, our work is based on the FSLSM, which is widely suggested for the improvement of the teaching quality Saracho (1997), Felder and Silverman (1988), and Kuljis and Liu (2005). Then, many studies have discerned the behavior of students during a course in order to identify patterns of behavior or characteristics associated to each learning style (Graf & Liu, 2010; Graf & Viola, 2009; Huang, Lin, & Huang, 2012; Ocepek, Bosnić, Nančovska Šerbec, & Rugelj, 2013; Slack & Norwich, 2007). These works have focused on the analysis of students' behaviors while performing different web-based actions such as navigating the web, using the email, and taking part in forums. As a difference, our work identifies the students' behavior