SCRUM-BASED AGILIZATION OF SOFTWARE ENGINEERING STUDENTS DURING PRACTICAL AND THEORETICAL EDUCATIONAL PROCESS: A CASE STUDY

Ljubica Kazi, Zoltan Kazi, Vuk Amižić, Igor Vecštejn

Abstract. *In the modern times of automation, human involvement in software development becomes less influential. The constant productivity and quality pressure force software developers to improve their capabilities to keep up with demands. Aim of this paper is to present a case study related to activities that aim to improve students' agility, simulating SCRUM methodology during educational process. The experiment was conducted with final year students attending advanced software engineering course at University of Novi Sad, Technical Faculty "Mihajlo Pupin" Zrenjanin, Serbia. The method included requirements for their work on daily basis (practical assignments) and weekly basis (theoretical assignments). The results show students' abilities to work under deadlines pressure and the impact of their agile work to the final subject outcomes – their grades.*

Key words: SCRUM Methodology, Agile, Productivity, Software Engineering, Students.

1. Introduction

Modern software industry is facing challenges of software development automation [1], which leads to specific concerns regarding human engagement in the industrial context [2], particularly in the context of global software development [3] and improving competitiveness [4].

Universities have important role in different areas and aspects of a society, with scientific and educational contributions, enforced with success criteria related to performance and productivity [5]. Universities evolve, in constant effort to align with industry, for the benefit of the economic development [6]. In this context, it is very important to adjust teaching content and methods to empower students' alignment to changing requirements in job market [7].

Agile behavior at working environment has been proved as one of key assets of every employee [8]. There are many factors influencing agility at workplace, such as positive workplace culture [9].

In software industry, agility is practiced with utilization of agile software

development methods [10] established with principles defined in Agile Manifesto [11]. Agile Movement lead to development of different agile software development process management methods and approaches, such as SCRUM, which is well-established in software industry [12, 13].

Agile methods evolved and merged during time, so one of contemporary approaches is SCRUM-based Disciplined Agile Delivery approach [14]. One of crucial aspects of Disciplined Agile (DA) approach is enterprise awareness in software development [14], which is related to the emphasizing role of business processes alignment to software solutions, within initial modeling, mapping, design and planning. The second aspect of this business alignment of software solutions within Disciplined Agile Delivery is placing the software solution within IT governance in the development of IT solutions for the organization, for the benefit of business processes and business success [15].

Aim of this paper is to present the method for agilization of software engineering students, based on SCRUM-based Disciplined Agile Delivery method. This method of students agilization has been applied at University of Novi Sad, Technical Faculty "Mihajlo Pupin" Zrenjanin, Serbia and the results are presented in this paper.

The rest of the paper is organized as follows. Section Background briefly introduces SCRUM-based Disciplined Agile Delivery method, which is the basis for the proposed method in this paper. Section Related work provides short review of previously published papers related to factors affecting academic productivity in higher education, with particular focus on teaching methods applied with software engineering students. Section Experiment describes experimental setup and results. Final section Conclusion brings discussion about results and possible future work directions.

2. Related Work

Benjamin Levin in his study [16] explored productivity in education, with particular effort in creating a mathematical expression to represent relationship between inputs and outputs in education. Key findings are related to students and their characteristics and effort as key factors in educational process outcomes. Psychology aspects, such as cognitive and emotional engagement [17], personality [18] and scientific attitudes (curiosity, respect of facts, critical thinking, discovery, creativity, open-mindness, cooperation etc) [19] influence students' academic succes and productivity. Depression impact to productivity has been addressed in research of Hysenbegasi et al [20]. Impact of technostress on academic productivity of university students has been addressed in research

of Upadhyaya & Vrinda [21] and Wickramasingha & Rebecca [22]. Health related issues and time pressure that impact productivity of university students has been addressed in research of Gusy et al. [23].

Hu & Kuh [24] explored students' perceptions of the campus environment that influenced students learning productivity, by using College Student Experiences Questionnaire. External factors that affect work productivity at universities (teaching and administrative staff and students) include work indoor environment. In research Liu et al [25], critical indoor envorinmental factors that affect productivity at universities include thermal confort, lighting, acoustic and privacy comfort, spatial comfort and aestetics.

Information technologies and software solutions support teaching and learning processes at all educational levels [26, 27]. Online courses bring novel types of collaboration and improve access to teaching content and teaching staff, increase interaction among students and students efforts [28]. Intelligent tutoring systems and adaptive assistance systems with proactive personalized help to students have been explored in the work of Maniktala et al [29]. Utilization of Generative Artificial Intelligence technologies in educational process, in aim to enhance productivity, particularly of teaching staff and students in Engineering field has been addressed in research of Al Naqbi et al. [30]. The influence of Chat GPT, as AI-powered writing tool, to academic writing of Indonesian university students has been presented in study by Sudarjad et al [31].

Using project based learning with collaborative learning for programming courses was explored by Acharya & Gayana [32], in aim to promote active learning techniques and analyze the impact of these approaches to productivity of students' learning. Research of Fuchs et al [33], addressed impact of workgroup structure and size impact to students' productivity during collaborative work on complex tasks. Aporbo [34] conducted a study in aim to investigate the effectiveness of cooperative learning on the students' academic productivity.

Success of a method application in industrial practice is influenced by previous training and practice. This has been particularly emphasized in the research of Cachero et al. [35], where SCRUM method adoption in teaching practice has been addressed in the context of empowering future junior software developers. Authors of this research proposed as a theoretical model of SCRUM method adoption to educational process and this model has been evaluated with students' attitudes (rating) of this model in comparison to other (traditional) practices.

3. The Proposed Method

In aim to improve students' educational productivity, as well as to align their work capacities and frequency to the needs of software industry, the method named AgDAD method (Agilization based on Disciplined Agile Delivery) is created for agilization of students within teaching process as derived from basic principles of SCRUM-based Disciplined Agile Delivery method [14]. Figure 1 presents the essential elements and activities within the proposed method.

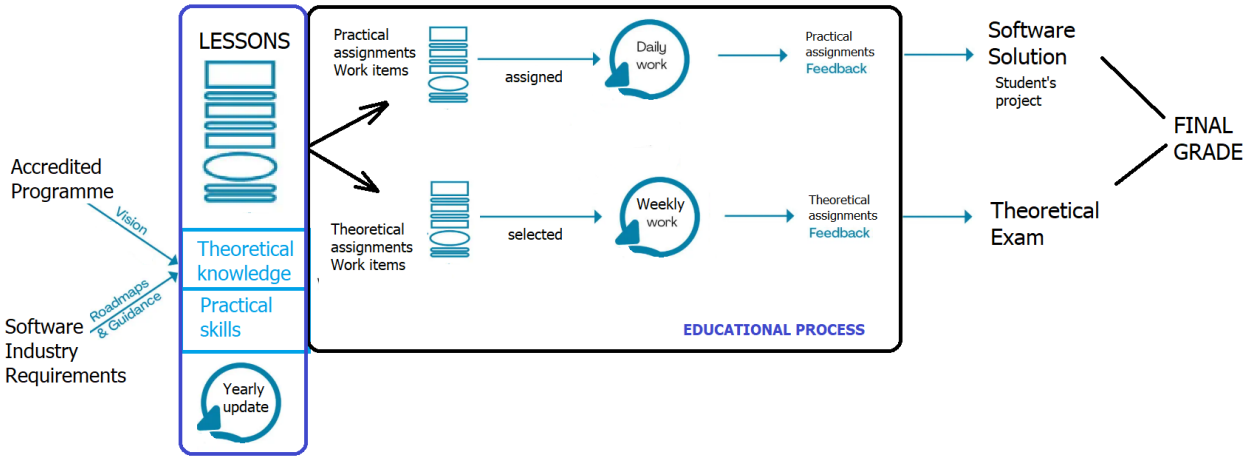


Figure 1. The proposed AgDAD method

The proposed AgDAD method consists of several levels:

1. Strategic level – each school year, a teaching plan is created to include contents from accredited programme (general topics – persistent for accreditation period, currently in Serbia: 7 years) and software industry requirements (dynamic – changes are frequent in technologies and methods).
2. Operative level – teaching plan is split into practical assignments and theoretical topics/questions for each week.
3. Assignment level – students attend practical and theoretical classes. At practical classes they have mandatory daily assignments (to finalize given tasks during class work). After theoretical classes they have mandatory assignments each week, but they are selective (to select questions for the list of theoretical questions and answer in a week period)
4. Evaluation level – students attendance and activity during attendance and evaluation of their works; students' engagement during classes are evaluated for their interaction (oral answers to questions) and quality

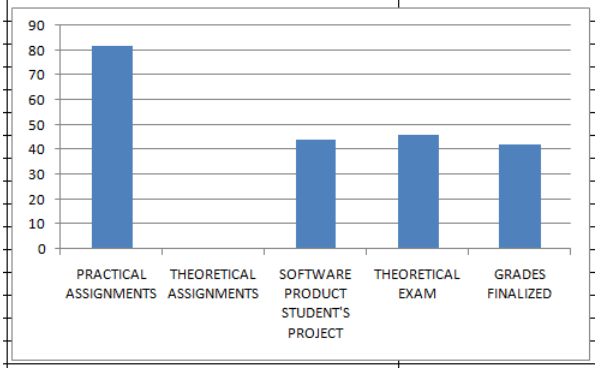
of their work (practical and theoretical – percentage of finalizing tasks, level of details, additional effort and creativity).

5. Feedback level – students are informed about their work with textual comments and points/marks they collect regarding: attendance, interaction, completeness of their work, additional efforts (extensivity), creativity (diverse or advanced solutions).

4. Experiment

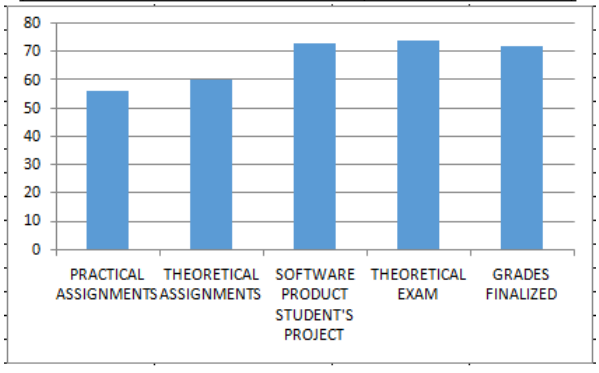
The AgDAD method has been utilized for several years at multiple subjects within Bachelor studies at University of Novi Sad, Technical faculty "Mihajlo Pupin" Zrenjanin, Serbia – at two study programmes: Information Technology and Software Engineering. In this paper, students' records are used to demonstrate effectiveness of the AgDAD method and they are used from final year students of Information Technology study programme, attending Advanced Software Engineering (*Softversko inženjerstvo 2*) course. Sample in this study include educational records from school years 2022/23 and 2023/24. Figure 2 presents comparative statistics of students' educational achievements for both groups of students.

Advanced software engineering 2022/23	%
PRACTICAL ASSIGNMENTS	82
THEORETICAL ASSIGNMENTS	0
SOFTWARE PRODUCT STUDENT'S PROJECT	44
THEORETICAL EXAM	46
GRADES FINALIZED	42



Statistics on educational achievements in 2022/23

Advanced software engineering 2023/24	%
PRACTICAL ASSIGNMENTS	56
THEORETICAL ASSIGNMENTS	60
SOFTWARE PRODUCT STUDENT'S PROJECT	73
THEORETICAL EXAM	74
GRADES FINALIZED	72



Statistics on educational achievements in 2023/24

Figure 2. Comparative statistics before and after using AgDAD method

Sample from school year 2022/23 include 84 students, during classes in that year there were no AgDAD method application, students were engaged only in practical classes tasks. The success was poor with only 42% finalized grades.

Sample from school year 2023/24 consists of 93 students, during practical and theoretical classes AgDAD method was applied and 72% grades were finalized.

5. Conclusions

Aim of this paper was to present AgDAD method, as a method of agilization of students in practical and theoretical classes. This method was conducted at several courses, but experimental results for this paper are presented regarding students educational records in Advanced Software Engineering course (at University of Novi Sad, Technical faculty "Mihajlo Pupin" Zrenjanin, Serbia). By comparing educational records of students' achievements from school year 2022/23 (without AgDAD method application) and 2023/24 (with AgDAD method application) it could be concluded that there is significant difference in overall educational success statistics. These results show students' readiness to be included in agile work, their ability to work under short deadlines pressure and the impact of their agile work to final goal – finalization of grades for that subject. This method also includes agility for teaching staff, having their obligation to frequently innovate teaching materials and methods, in aim to align teaching process with the needs of business environments.

This research show some limitations, since it presents a case study with small sample (only two school years, only one course and one university school – faculty). However, this method is applicable at any level of education and any area of knowledge – it is not specifically related to IT field and software engineering. Future directions of this research could be related to broad context of teaching methods effectiveness, especially in the context of closer collaboration with industrial needs, standards and technologies, where industry could be more closely engaged in teaching content and knowledge/skills evaluation formulation and assessment.

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Ethics committee from University of Novi Sad, Technical Faculty "Mihajlo Pupin" Zrenjanin approved this paper to be published, as being completely aligned with professional ethics (No: 01-2201 issued 18.November 2025).

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