SCRUM in Education: An approach to teaching programming in technical courses in Internet Informatics

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ABSTRACT

Currently, technology has attracted attention in several aspects, both in terms of launches and new technologies, as well as the demand for professionals in the area. The search for courses around computer science and programming is growing. In line with this, it is possible to observe that the market is becoming increasingly demanding regarding deliveries. Observing this scenario, the present work aims to propose and evaluate an adaptation to the agile method of Scrum development, for the teaching of programming in technical courses of Internet Informatics. For this, first, the method was adapted to the educational context and used by a class of 20 students, in a development discipline. The results show that the approach can be effective and present positive results in terms of teaching the content.

Keywords: Agile Method, EPT, Internet Computing.

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INTRODUCTION

Due to the growing demand for software products, as well as the technological evolution of recent years, the software market seeks to adapt and adjust to the current scenario. Thus, it can be observed that agile methods were present in this evolution. As pointed out in the *14th Annual State of Agile Report* (VERSION ONE, 2020), Scrum and some related variations are the most used agile methodologies in organizations.

In parallel to this, the demand for professionals in the area of information technology is growing (WOLFF, NORONHA AND ANDRETTA, 2021). Wolff, Noronha and Andretta (2021) point out that the area employs 1,196,000 young people. Moreover, it is notable that access to the internet, and even digital literacy, has been current issues. This means that many people who previously did not use the internet and computing devices now use it for specific purposes.

Considering programming professionals, in addition to undergraduate courses, such as computer science, information systems and software engineering, for example, the national catalog of technical courses includes the Technician course in Informatics for the Internet[3]. Professionals in this area plan, develop, monitor, structure, code, publish, and maintain web and mobile applications, including the management of structural, visual, and database elements.

Taking into account that students will often be inserted in companies that use Scrum as a development method, it is understood the importance of safeguarding students both quality teaching of the stages and particularities of the method and the programming content. This work addresses the interrelationship between the teaching of programming and Scrum, with the objective of adapting the Agile Scrum Method in technical teaching in computer science to the internet, and to evaluate the perception of teachers and students about the application of the method in the classroom.

To achieve the objective, a work proposal was developed with adapted Scrum, in a class of technical course in computer science for the internet, during the Client-side Programming discipline. The students were separated into Scrum teams, and received subsidies to conduct the activity, creating a relationship with the real environment.

After conducting the project, it was possible to observe and evaluate the results of the products prepared by the students, as well as to collect *feedback* from the participants about the application of the method in the study context. In addition, it was possible to collect and document the points observed by the participating professor.

The results of the study indicated positive aspects in the three dimensions analyzed. The perception of the teachers revealed a good acceptance of the adapted method, demonstrating its effectiveness as a didactic tool. The participating students reported mostly positive experiences,

[3] National Catalog of Technical Courses: http://cnct.mec.gov.br/cursos/curso?id=83

highlighting significant contributions to their training. The adaptation of the method was carried out as expected, preserving its essential pillars and main characteristics.

This work is organized as follows: first, in Section 2 the fundamentals that guide this work are presented. Section 3 presents the methodology adopted in the project, with all pertinent details. Section 4 presents the results obtained with the project. Finally, in Section 5 the final considerations.

THEORETICAL FOUNDATION

The guiding fundamentals of this work are associated with software programming and development, the Scrum methodology and the technical course in computer science for the internet. Below, these essential concepts for the development and understanding of this project will be presented.

PROGRAMMING AND SOFTWARE DEVELOPMENT

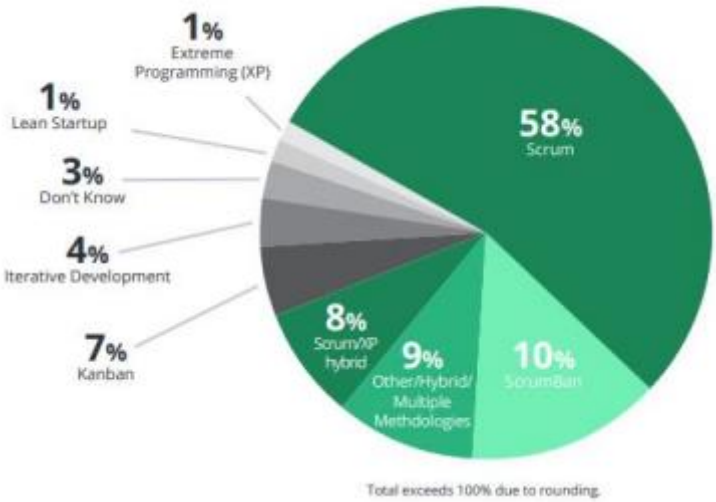
The term programming refers to the language behind the development of software, websites, applications, and various technologies (BALBINO et al., 2021). In this process, a set of instructions is elaborated that a computer can follow to perform certain tasks. Through programming, developers use specific languages to write codes that direct the operation of computers and devices, allowing the creation of technological solutions (BALBINO et al., 2021).

When it comes to software development, there are two approaches that stand out, the traditional approach and the agile approach. As directed by Curcio et al. (2018), there are differences between these two contexts, so that in the traditional context every requirements stage is carried out only in the initial phase of the project, while in the agile context, the requirements can undergo changes and adjustments throughout development (CURCIO et al., 2018; SCHON et al., 2017). Thus, continuous requirements management in agile approaches is essential (SCHON et al., 2017).

SCRUM

Scrum is a framework for developing and maintaining complex products (SCHWABER & SUTHERLAND, 2013). The authors Schwaber & Sutherland (2013) point out that Scrum is a set of guidelines that enable people to approach and solve complex and adaptive problems, productively and creatively delivering products with the maximum possible value. As pointed out in the *14th Annual State of Agile Report* (VERSION ONE, 2020), Scrum and some related variations are the most used agile methodologies in organizations (see Figure 1).

Figure 1: Agile methodologies

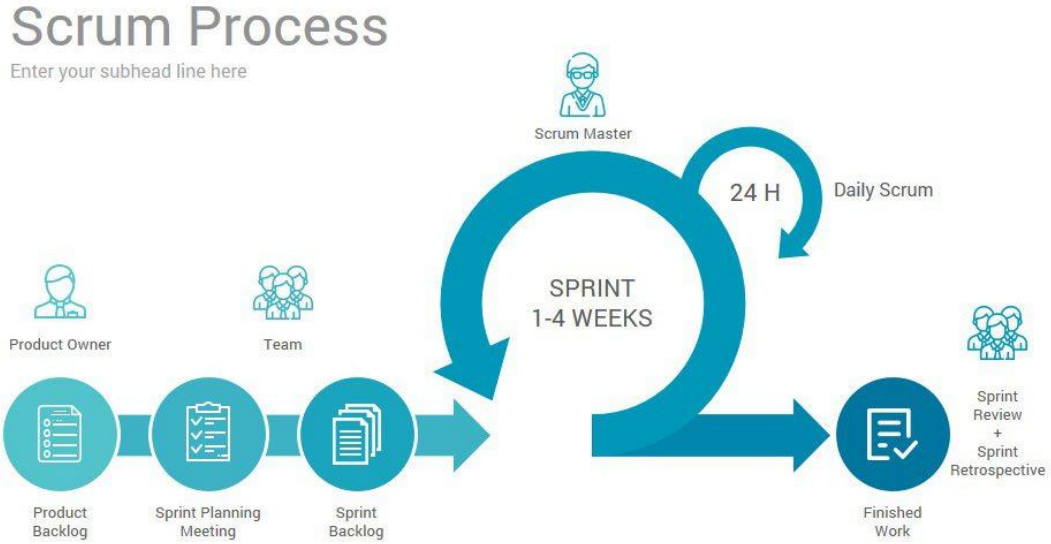


Fonte: 14th Annual State of Agile Report. (digital)

Scrum has been used to manage the development of complex products since the early 1990s (SCHWABER & SUTHERLAND, 2013). Scrum is not a process or a technique for building products; rather, it is a framework within which you can employ various processes or techniques (SCHWABER & SUTHERLAND, 2013).

The Scrum framework is composed of Scrum teams, linked to roles, events, artifacts, and rules (see Figure 2). Each element within this framework has a specific function and is crucial to the application and effectiveness of Scrum.

Figure 2: Scrum Process



Source: Trainning Marketing Team

TECHNICAL COURSE IN COMPUTER SCIENCE FOR THE INTERNET

The Technical Course in Informatics for the Internet is part of the National Catalog of Technical Courses[4]. Among the activities developed by professionals in this area, *client-side* development; interface development for web pages; front-end testing; database modeling and implementation; *back-end* testing; web systems development; among other activities.

It is expected that the graduate of this course will be able to develop web systems, produce interfaces, databases and functionalities, according to methodologies and standards of quality, usability, ergonomics, accessibility and security.

METHODOLOGY

To achieve the established objective, a methodology was defined (see Figure 3) divided into two stages. The first stage consisted of the adaptation of the Agile Scrum Method, followed by its implementation in the context of technical education.

Figure 3: Methodology used

Source: from the author

SCRUM'S ADAPTATION

To adapt the Scrum method, it was first necessary a detailed analysis of the method itself, which is usually intended for a real development environment. This analysis sought to identify key factors of the method, that is, characteristics that are essential for its use.

After understanding the official method, the adaptation to the desired context began. Considering all the details of Scrum, the method was divided into three parts: Pillars, Events, and Roles.

According to Schwaber & Sutherland (2017), the Pillars refer to the fundamentals that support the method, such as transparency, inspection, and adaptation. Events encompass the scheduled activities that structure and organize the workflow, such as planning meetings, reviews,

[4] Link: http://cnct.mec.gov.br/cursos/curso?id=83

and retrospectives. Finally, Roles define the responsibilities of team members, including the Scrum Master, Product Owner, and Development Team.

Tables have been developed (which will be presented in Section 4) for each part of the Scrum method. Each of them was separated into three columns, so that the first column demonstrated the terms (Pillars, Roles and Events), in the second column the definitions of these in their original form and the third column the adapted definition.

To make the adaptation, it was necessary to consider the classroom context, specifically in the technical course in computer science for the internet. The adaptation was conducted in stages, so that, for each pillar, role or event, the original definition was read, understood and analyzed for its applicability in the school environment. This process was carried out in detail for each of the topics.

The importance and need for teacher participation and experience at this time is highlighted, as this allowed the consideration of routine and common situations and behaviors in the classroom. This was fundamental to ensure that the adaptation was in fact appropriate for the educational context.

IMPLEMENTATION OF THE PROPOSAL IN EFA

The adaptation of the agile method aimed to apply it in the context of technical education. In this sense, the proposal of this work consisted of the second crucial phase: to apply the method in a real environment of programming study, specifically in the technical course in computer science for the internet. The proposal was carried out in a class composed of 20 students, with an average age of 18 years. It is important to note that none of the participants had previous knowledge about the Scrum method, since they were all at the beginning of their professional careers.

Over the course of a week, during school days, students were actively involved in the proposed scenario. The project was conducted over four hours a day, with 15-minute breaks, in a computer lab. This configuration allowed all students to have access to computational devices for the development of the proposed project.

Contextualization

The initial phase of the application involved contextualizing the students in relation to the Scrum method in its original form. This stage played a key role in allowing students to understand not only the concepts inherent to the method, but also the reason why it is widely adopted in the context of development, highlighting the importance of acquiring knowledge to integrate teams that use this method throughout their professional careers. This phase was conducted through the method

of dialogued exposition[5], which enabled the interaction of the students, allowing them to clarify doubts at any time and share different perspectives.

A slide presentation was prepared to facilitate the explanation of the method. During this presentation, each concept of SCRUM was carefully addressed, offering detailed information for an understanding of the method. At the end of the contextualization, this presentation was made available to the students, serving as a support resource and a reminder of the concepts, in case they needed to remember any information.

Definition of the teams

In the adapted context of the project, each Scrum team consisted of four participants, totaling five teams. The selection of members followed a specific criterion: initially, five volunteers applied to assume the role of PO (Product Owner) in their respective teams, with emphasis on the need for an appropriate profile based on the concepts studied.

After choosing the POs, each one selected a colleague to act as Scrum Master, considering the understanding of the content presented during the contextualization phase and the ability to play this role. That left ten students to form the development teams. To compose the Scrum teams, the teacher in charge selected a student for each team, taking into account the profile and skills demonstrated throughout the classes, aiming to create balanced teams. The last member of each team was defined by lottery.

In this way, five Scrum teams were established, in which members created a name for their teams, consisting of a PO, a Scrum Master and two developers.

Presentation of the project

With the teams already formed, a presentation of the project that would be developed throughout the week was held, focusing on the overview and avoiding specific details, which would be addressed later. The project consisted of creating the *front-end* of an equipment maintenance demand management system, covering corrective, preventive, and other categories.

In this stage, it is highlighted that the teacher played the role of client, presenting the demands, preferences, perspectives and expectations in relation to the deliveries. During the presentation of the project, the client (represented by the professor) held meetings with the POs of each team to gather requirements, seeking to provide more details about the demands. It is important to note that the professor, at this moment, avoided the use of common technical terms among

[5] An educational strategy in which the teacher acts as a mediator, facilitates the active participation of students, considering their previous knowledge and encouraging questioning.

developers, assuming the posture of a lay client in programming. This approach sought to simulate a real context as much as possible, aiming to improve the students' skills.

Development

With the requirements properly documented, the teams began the development phase of the project. Following the adaptation mentioned in Section 3.1, each day was treated as a *sprint*. At the end of each day, the teams committed to delivering an increase in the product. For this, in addition to the beginning of the class, considering 15-minute intervals, the teams performed the so-called Daily Scrum when returning from the break.

During development, the POs had the function, in addition to assisting in development, of providing support regarding the doubts that arose. The Scrum master aimed, in addition to assisting in development, to keep the team within the proposed method. Dialogue between students and mutual contribution within the team was encouraged. Just as it is provided for in the method.

In addition, the POs took responsibility for defining the prioritization of the *product backlog and the* sprint, *without direct interference from the faculty member in the students' decision-making.*

The professor encouraged students to seek solutions to the challenges encountered within their own teams, aiming to make the most of individual skills and promote communication and collaborative work. However, at certain times, it was necessary to offer technical support to the teams, limited to the content of the disciplines in progress, without interfering in decisions related to the project itself.

The teams adopted the Trello tool for the management of activities, requirements and support in general, with each team having its own board on the platform. It is important to mention that the professor was included in the staff of all the teams, allowing him to follow and observe the different approaches adopted by the teams in the management of the projects.

In order to ensure daily deliveries of increments in the software, students were brought together in a virtual classroom through *Google Classroom*[6]. To facilitate this process, activities were created for each day, allowing teams to make the corresponding deliveries. The teams delivered their codes, making them available for testing.

Feedback

At the end of the project, a stage was carried out to capture the students' perceptions regarding the application of the adapted Scrum method during classes, aiming to understand not only the teacher's vision, but also the students who effectively participated in the teams.

[6] https://edu.google.com/

Initially, an informal dialogue was held between the students and the professor. In this context, students were encouraged to sincerely express their perceptions regarding the project. Subsequently, using the Google Forms platform[7], a questionnaire containing nine questions about the use of Scrum during classes was sent to the students. The form included eight open questions to collect information in a qualitative way and a final question based on an evaluation scale, seeking to obtain a quantitative perception of the acceptance of the method by the students.

Table 1 presents the questions made available to students in order to collect feedback.

Table 1: Feedback Collection Questions

Question	Question
1	What were the two main benefits you identified when using the SCRUM methodology during programming classes?
2	How did these positive points directly impact your learning process?
3	What were the two main challenges or negative aspects you encountered when using SCRUM in programming classes?
4	How did these negative points influence your learning experience and interaction with the methodology?
5	How would you describe your general perception of using the agile SCRUM method during programming classes?
6	To what extent did the application of SCRUM contribute to the dynamics of the classes and to the achievement of the learning objectives?
7	In your opinion, what contributed most to your training when using SCRUM in programming classes?
8	What are the specific points that you consider that can be improved in the application of SCRUM in programming classes?
9	On a scale of 1 to 10, how do you rate your learning when using SCRUM in programming classes?

Source: author.

Participation in the *feedback* stage was voluntary, ensuring the anonymity of the students. The link to the form was made available so that participants could respond, without the obligation to participate. In total, there was the participation of 16 respondents. The full answers are found at the link[8].

RESULTS AND DISCUSSION

The present study presents three main results: the adapted method, the teacher's perceptions about the application of the method and the students' perceptions, based on their feedback.

ADAPTED METHOD

In this section, the modifications and adaptations made to the original method are detailed. The adaptation process was carried out following three perspectives, namely: regarding the Pillars, the Roles and Events. Thus, the results were presented in a similar way. Table 2 presents the

[7] https://www.google.com/intl/pt-BR/forms/about/
[8] https://tinyurl.com/uyn6a6m6

adaptation made to the Scrum pillars (transparency, inspection and adaptation). It can be observed that there were no significant changes regarding the Scrum pillars, since they are the basis of the method and their main characteristics must be preserved. We sought to simplify the description of the topics as much as possible, aiming at ease of understanding and easy adaptation to teachers who are not specialists in agile methodologies.

Table 2: Adapting the Scrum Pillars

Pillar	Guia Scrum (SCHWABER & SUTHERLAND, 2013)	Adaptation
Transparency	Significant aspects of the process should be visible to those responsible for the results. For this, transparency based on a common standard is necessary, allowing for a shared understanding among observers.	Keep information about progress and goals visible, with regular feedback, so everyone knows the status of activities and what's expected.
Inspection	Scrum users should frequently inspect artifacts and progress for variance.	Frequently review the progress of activities and projects to identify and correct deviations.
Adaptation	Adjustment must be performed quickly to minimize deviations. Scrum prescribes four formal events within the Sprint: Sprint planning meeting, daily meeting, Sprint review meeting, and Sprint retrospective.	Perform quick adjustments at any time to correct deviations.

Source: author.

In addition to the pillars of the method, it was necessary to adapt to the Scrum Roles (product owner, development team and scrum master). The adjustments made are presented in Table 3.

It can be observed that the adapted method directly mentions the educational context, through the terms "student" and "students". This adaptation seeks to work in a more specific way, without requiring correlation on the part of the teacher or effort to understand.

Table 3: Adaptation of Scrum Roles

Paper	Guia Scrum (SCHWABER & SUTHERLAND, 2013)	Adaptation
Product Owner (PO)	The person in charge must maximize the value of the product and the work of the Development Team, clearly express the items in the Backlog, order them to better achieve the goals, ensure the value of the work done, ensure the visibility and clarity of the Backlog, and ensure that the Development Team understands the items at the necessary level.	The student is tasked with maximizing the value and effectiveness of the project. It defines and prioritizes tasks, ensuring alignment with goals. It is the point of contact with the faculty member (representing the client) who defines the project requirements. The PO ensures that the team understands and executes what was requested, keeping the project clear and accessible to everyone.
Development Team	Delivers the product at each Sprint, being responsible for creating the increments. They are self-organized and possess all the necessary skills to perform the job efficiently and effectively, ranging usually from 3 to 9 members.	There should be 3 to 5 students who work together to deliver a working version of the project at the end of each stage. They must be organized and trained to plan and manage their own work autonomously. There must be collaboration within the team. Is cross-functional, having the skills necessary to get the job done and achieve project objectives.
Scrum Master	The Scrum Master is responsible for ensuring that Scrum is understood and applied correctly. He acts as a servant-leader for the Scrum Team, ensuring that the team follows Scrum theory, practices, and rules. In addition, the Scrum Master helps people outside the Scrum Team understand how to interact in a useful way with the team, maximizing the value created by Scrum.	The Scrum Master is responsible for ensuring that the principles and practices of Scrum are understood and applied by the group of students. He acts as a guiding leader, helping the team to follow the guidelines and rules of Scrum. In addition, it helps other students understand how to interact effectively with the Scrum Team, identifying beneficial interactions and optimizing them to maximize the value created by Scrum.

Source: author.

The last adaptation perspective addressed the Scrum Events, as shown in Table 4. This perspective was the one that presented the most changes in fact, in relation to the original method. This is because the main difference in contexts is in relation to the time dedicated to projects. In the professional environment, employees usually allocate approximately eight hours a day to the project (considering a 40-hour workweek). The educational environment differs from dedicating daily hours to the project. Furthermore, regarding the time available for each Sprint (see Table 4), since the schedule available for conducting the disciplines must be respected and generally many other issues must be worked on within the discipline.

Table 4: Adapting Scrum Events

Event	Guia Scrum (SCHWABER & SUTHERLAND, 2013)	Adaptation
Sprint	It is a period of one month or less where a usable version of the product is developed. During the Sprint, no changes are made that compromise the objective, quality goals are maintained, and the scope can be adjusted as needed. Each Sprint is a short-term project, providing continuous predictability, inspection, and adaptation, while limiting risk to one month.	Period of a class day, where an incremental and potentially usable version of the product is developed. Each sprint (one day) is like a short-term project, providing predictability, inspection, adaptations, and continuous improvements.
Sprint Planning Meeting	The work to be carried out is planned collaboratively by the Scrum Team. This meeting has a time limit, usually eight hours for a month-long Sprint, and is led by the Scrum Master, ensuring that the event takes place and that everyone understands its purpose. During this meeting, questions such as what can be delivered as a result of the next Sprint increment and how the necessary work will be carried out are addressed.	In the "Sprint" planning meeting (which corresponds to a class), the work to be carried out is planned collaboratively by the group of students. This meeting has a time limit of 30 minutes and is conducted by the Scrum Master, ensuring that the event takes place and that everyone understands its purpose. During this meeting, issues such as what can be achieved during class and how the necessary work will be carried out to achieve the learning objectives are discussed.
Daily Scrum	The Daily Scrum Meeting is a 15-minute event, where the Development Team synchronizes and creates a plan for the next 24 hours. During this meeting, the work since the last meeting is inspected and the work to be done before the next meeting is forecasted. The Daily Meeting is held at the same time and place each day to reduce complexity. During the meeting, the members of the Development Team clarify: What did I do yesterday that helped the Development Team meet the Sprint goal? What will I do today to help the Development Team meet the Sprint goal? Do I see any obstacles that prevent me or the Development Team from meeting the Sprint goal?	Event of no more than 15 minutes, which should occur every 2 hours, where students synchronize and plan their next activities. During this meeting, progress since the last meeting is reviewed and tasks to be accomplished before the next meeting are planned. Keeping the same time and place, students answer the following questions: What have I done since the last meeting to contribute to the progress of the group? What will I do in the next few hours to help the group achieve our goals? Is there an obstacle that is hindering my own progress or the progress of the group?
Sprint Review and Sprint Retrospective	The Sprint Review is performed at the end of the Sprint to inspect the increment and adapt the Product Backlog if necessary. During the Sprint Review, the Scrum Team and stakeholders collaborate on what was done in the Sprint and plan the next actions to optimize value. This informal meeting, intended to motivate and get feedback, lasts 4 hours for a month-long Sprint, and is shorter for smaller Sprints. The Scrum Master ensures the accomplishment and understanding of the meeting's objective, teaching everyone how to keep it within the time-box. The Sprint Retrospective is an opportunity for the Scrum Team to inspect itself and plan improvements for the next Sprint. It takes place after the Sprint Review and before the planning meeting for the next Sprint, lasting three hours for a one-month Sprint, and shorter for smaller Sprints. The Scrum Master ensures the accomplishment and understanding of the purpose of the meeting by participating as an auxiliary member due to their responsibility for the Scrum process.	The Sprint Review and Sprint Retrospective are carried out jointly. It is the moment when students and others involved meet to analyze the progress achieved during the study period and identify opportunities for improvement. During this meeting, the focus is on reviewing what has been learned, celebrating successes, and identifying challenges faced. In addition, participants collaborate to identify ways to enhance the learning process and maximize future outcomes. The Sprint Review and Sprint Retrospective provide a valuable opportunity for reflection, continuous learning, and students' personal and professional development as software developers.

Source: author.

TEACHER'S PERSPECTIVE

Another result obtained with the execution of this project was regarding the perception of the participating teacher about the application of the adapted method. Considering the limitations of classes and teams, only one teacher applied the method. Their perceptions were collected through an experience report.

Among the points observed, the professor reported that the students felt motivated by a different and more participatory approach. They showed interest in knowing more about the Scrum method, and were open to knowing the peculiarities of the method.

It was reported that, during the division of the roles, the students' profiles were present. Thus, more participative and communicative students were willing to lead the roles of PO. Those interested in taking on the role of Scrum master were the students who have a more methodical profile. The less participative students in class did not express interest in taking on roles other than the Development Team.

Analyzing the general context, it was possible to notice that the students were able to understand the Scrum method in its original format, even using the proposed method (adaptation). The professor also noted that the students were comfortable for new challenges using the method. This achieves one of the objectives, which is to provide subsidies so that students can develop the necessary skills to use agile methods in real work environments.

The main negative point reported by the professor refers to the participation of students who worked with the role of "development team". It was possible to observe that the development team at times felt comfortable not having the greatest responsibilities before the group. Involuntarily, these students saw at times the PO and Scrum Master as the only ones responsible for the project, thus relieving the responsibility of the other team members. This fact is not desirable, since it is desired that all members of the group divide the responsibilities in a balanced way, regardless of the role assumed in the project.

STUDENT PERSPECTIVE

In this section, students' perceptions of the adapted method are explored, based on their feedback. Their experiences and opinions about the method were analyzed, as well as suggestions for future improvements.

The main benefits identified by students when using the Scrum methodology during programming classes include improved organization and distribution of tasks, increased collaboration and teamwork, and flexibility and adaptability, as can be seen in Table 5.

Table 5: Student Feedback - Question 01

What were the two main benefits you identified when using the SCRUM methodology during programming classes?
"division of activities and organization of projects"; "More organization and good distribution of time and tasks for everyone in the group"; "Learning by working as a team"; "The separation of the 'tasks' of each one in the team, so to speak, helped in the organization of the group to have ideas, separate functions and etc."; "It was very positive, the methodology aims at a single and agile process in a single objective"; "I can't say"; "It made it much easier to separate tasks and communicate between the team, speeding up the delivery of work"; "The main benefit I noticed was that our work team was able to bring an organization and requirements that will be done on the day much more practical and faster, having a distribution of tasks and less time spent"; "The teamwork has been greatly optimized, the simple matter of getting everyone up to date on their respective individual jobs makes the workflow more enjoyable and less burdensome for everyone involved"; "I felt that it was more dynamic and allowed everyone in the group to collaborate"; "To be able to organize the development group"; "Among so many objectives, the two main ones can be highlighted: the increase in flexibility and adaptability of each member of the group to the project worked on and also a higher quality of service, always maintaining a clean path, each member with their proper function"; "Better organization of group activities and better communication among participants"; "Two positive points, in my opinion would be both communication and quality of teamwork, due to the fact that Scrum about its methods"; "Clearer organization of the project and faster execution"; "It makes everyone focus on work and makes everyone bring more results".

Source: author.

Many students highlighted how Scrum helped to organize activities and projects more clearly and efficiently, with answers such as *"division of activities and organization of projects"* and *"more organization and good distribution of time and task for everyone in the group"*. This structure helped to speed up the delivery of work and facilitated communication within the group, making the work more enjoyable and less burdensome, as mentioned in *"it made it much easier to separate tasks and communicate between the team, making it speed up the delivery of work"*.

Another significant benefit was learning from working in a team. Comments such as *"learning by working as a team"* and *"teamwork has been greatly optimized"* indicate that Scrum has fostered effective collaboration among students. Constantly updating on individual and collective progress has helped keep all group members engaged and focused, resulting in a more dynamic and productive work environment. The flexibility and adaptability provided by Scrum were also valued, the students highlighted the ability to quickly adjust plans according to needs, as noted in *"increased flexibility and adaptability of each member of the group to the project worked on"*.

Additionally, the Scrum methodology suggests an improvement in communication between participants, which is essential for the success of collaborative projects. Answers such as *"better communication between participants"* and *"made it much easier to separate tasks and communicate between the team"* show that the Scrum structure, with regular meetings and clear objectives, promoted more efficient and effective communication.

It is important to highlight that not all students were able to identify clear benefits, as indicated by the answer *"I can't say"*. In addition, the sample of responses may reflect a positive bias due to the specific context and individual perceptions of the students. Extending this analysis to

different educational contexts can provide a more comprehensive view on the effectiveness of Scrum in the learning environment.

Table 6: Student feedback - Question 02

How did these positive points directly impact your learning process?
"practicality and agility of projects"; "yes"; "In a future, knowing how to work as a team"; "I agree that after scrum it is easier to visualize a way of working in a group, in a less limited, lighter way"; "drastically, with agility in the creation process"; "I can't say"; "It's easier to divide each part of the work, and everyone on the team can collaborate"; "A much more elaborate group organization, separating tasks that many have more ease and difficulty, so I was able to perform well in many activities"; "You learn what you need to do your job and you also learn a little bit of the other's work. We also learned that it is an optimized way of working as a team"; "It allowed collaboration between my team members in times when we had difficulties"; "be more productive"; "Provided a clearer understanding of projects, promoting a comprehensive vision and improving continuous adaptation to change"; "Greater ease to understand how the project was going"; "Points that impacted were the fact that you can work in a successful team by having the Scrum method and the tasks make it easier"; "They showed a better way to start planning a goal"; "It helped me stop procrastinating."

Source: author.

Table 7 presents the answers regarding the main challenges or negative aspects perceived when using Scrum during programming classes. From these answers, it is possible to identify common patterns of experiences and challenges shared by students. This provides important *insights* to improve the implementation of Scrum in the educational environment and improve the learning experience for students.

Table 7: Student Feedback – Question 03

What were the two main challenges or negative aspects you encountered when using SCRUM in programming classes?
"judgment as a client and organization of projects of importance"; "I don't remember a single negative point"; "A well-organized work, The lack of courage of a member to take the position"; "maybe in relating the profile of each person to each function, because we don't always assign tasks to people specifically trained to solve that"; "adaptability to change"; "I can't say"; "The separation of tasks for each team member"; "Some negative point that can occur is the lack of commitment and collaboration of the team, occurring instead of using SCRUM to raise requirements and tasks, use it to discuss other types of issues"; "as it was not in a professional sector in fact, people had their difficulties to get into character"; "The main difficulty encountered was to understand how the SCRUM method worked and how we were going to apply it"; "Responsibilities and division of tasks"; "When using the methodology, a VERY impactful challenge in our project is that it required the EXTREME collaboration of all team members, so that a continuous workflow was maintained. Another point I can mention refers to the commitment of the team, in cases of lack of commitment, it hindered a good part of the work"; "In the division of activities there may be some discussions and difficulties with some participants who did not do their part"; "In a matter of discussing team choices, and there may be a conflict of your choices for using Scrum"; "Adapt to the circumstances and communicate clearly with the other team members"; "The biggest challenges were working hard to show results and paths to be followed."

Source: author.

Students' feedback on the challenges or negative aspects of using Scrum in programming classes reveals a range of perceptions and experiences. It is interesting to note that some answers highlight positive points, such as the organization of work, the separation of tasks and adaptability to change, while others reflect more specific challenges, such as the lack of commitment of the team, difficulties in the division of activities and communication between members.

An important note is that some students mention not having identified any negative points, which may indicate different levels of experience or understanding of Scrum. This underscores the importance of a good understanding of the method and proper implementation to ensure positive results. One student said, *"I don't remember any negative points."*

Another relevant point is the issue of team commitment, highlighted by several participants. One of the students commented, *"A VERY impactful challenge in our project is that it required the EXTREME collaboration of all team members to maintain a seamless workflow. Another point I can mention refers to the commitment of the team, in cases of lack of commitment, it hindered a good part of the work"*. This suggests the importance of a collaborative and engaged culture for the success of the Scrum methodology.

Additionally, the need to adapt to circumstances and clear communication between team members are essential to overcome challenges and ensure better method execution. One of the students highlighted: *"The separation of tasks for each team member"* as one of the challenges, while another mentioned: *"Adapting to the circumstances and communicating clearly with the other team members"* as a difficulty encountered.

Overall, feedback provides valuable insights into students' perceptions and experiences with Scrum. They highlight both the benefits and challenges of the methodology, emphasizing the importance of careful implementation, team commitment, and good communication to achieve the positive results.

The negative points identified by students when using Scrum in programming classes (see Table 8) influenced their learning experiences and interaction with the methodology in several ways.

Some students reported that the "*lack of practice for the job market"* and the *"lack of commitment"* of some team members resulted in delays in work, making it difficult to effectively apply Scrum. One student mentioned: *"I mainly find that doing group work has many people not doing their tasks and staying idle, often having one or another person to do many activities."* This type of situation can generate overload for some members, compromising the collaborative learning experience that Scrum aims to provide.

Table 8: Student Feedback – Question 04

How did these negative points influence your learning experience and interaction with the methodology?
"lack of practice for the labor market"; "no"; "To a delay in all work"; "little denial, it didn't hinder my team so much, but it is to be considered that in other situations this problem may hinder"; "We cannot say negative experience, but rather in great stages to be long."; "I can't say"; "It made it a little complex at first, but then it got easier."; "I mainly think of doing group work that has many people not performing their tasks and being idle, often having one or another person to perform many activities."; "Sometimes you couldn't take the dynamic very seriously, because there was no real commitment."; "There were some delays in being able to implement this method"; "I don't think they are so important to influence learning"; "In a way, these negative points ended up causing others that influenced my experience, as well as the pressure with time management, causing stress, thus making even clearer the importance of internal communication in a group that needs teamwork."; "Leaving some people overloaded and others with little work."; "Different opinions that cause conflicts because not everyone on the team agrees with your ideas."; "They made me reflect on work in real situations"; "They actually helped with learning."

Source: author.

The initial difficulty with the methodology was a recurring point, but many students recognized that this complexity was overcome over time, as indicated in the sentence: *"It was a little complex at first but then it became easier"*. The pressure with time management and the need for effective communication within the team were also aspects that negatively impacted, generating stress and highlighting the importance of internal communication. One student reflected: *"In a way, these negative points ended up causing others that influenced my experience, as well as the pressure with time management, causing stress, thus making even clearer the importance of internal communication in a group that needs teamwork."* These challenges, while problematic, have also provided valuable learning opportunities about teamwork and project management in real-world situations.

The students' general perceptions regarding the use of the agile Scrum method during programming classes were, for the most part, very positive, as can be seen in Table 9. Many highlighted the effectiveness of the method in quickly delivering the minimum viable product to the customer, allowing a clear perception of the final product. One student mentioned: *"high quality if applied correctly like this, being able to deliver the faster the minimum viable product to the customer, to have a perception of the final product"*. In addition, the methodology was considered very useful for learning and understanding how Scrum works and its functionalities. One student reported: *"In fact, it was very useful for my learning and seeing how this SCRUM works, knowing more about it and its functionalities"*.

Table 9: Student Feedback - Question 05

How would you describe your general perception of using the agile SCRUM method during programming classes?
"high quality if applied correctly like this, being able to deliver the fastest the minimum viable product to the customer, to have a perception of the final product"; "In fact, it was very useful for my learning and seeing how this SCRUM works, to know more about it, about its functionalities"; "A very good learning for the future"; "very simple to understand and put into practice, being effective in many cases, where you know how to use it"; "The Scrum methodology encourages a practical and results-oriented approach to students in an agile way."; "It makes things better, as it makes us able to adapt better to the customer and still make it possible to have better interaction between developers"; "I thought it made it much easier to carry out the work."; "It is clearly necessary, it always happens that many groups have idle members or without ideas, so SCRUM is something that when used can transform the formation of a good work."; "Very good, the method is effective for development and reduces unnecessary efforts."; "It is a way to speed up the programming process formed by groups"; "It was interesting because it flowed well"; "I would describe it positively, as it provided me with a practical and collaborative approach. Despite some challenges, the methodology stimulated agile adaptation, improved communication and promoted the direct application of the knowledge previously studied."; " Very productive. It brought a new way to work in a group that helped in communication."; " It's an excellent method, it can help a lot in a way for your team that will work together, specifically agile, adaptation and how to collaborate."; " Objective"; "My perception is that it makes you challenge yourself to deliver before the deadline, so you have a greater work focus."

Source: author.

The practical applicability of Scrum has also been frequently praised. Many students appreciated how the methodology encouraged a practical and results-oriented approach, making it easier to carry out the work. One participant commented: *"I thought it made it much easier to carry out the work"*, while another highlighted: *"The Scrum methodology encourages a practical and results-oriented approach to students in an agile way"*. The methodology was seen as a way to improve interaction between developers, increase productivity, and reduce unnecessary efforts. As one student put it, *"It's a way to speed up the process of programming formed by groups."* These feedbacks indicate that, despite the challenges faced, the use of Scrum in classes provided a collaborative and effective learning experience, improving communication and promoting the direct application of the knowledge acquired.

As can be seen in Table 10, the students positively evaluated the application of Scrum, highlighting several ways in which it contributed to the dynamics of the classes and to the achievement of the learning objectives. One student commented that the method contributed *"on a large scale"* and that *"communication mainly improved, in coming up with ideas together mainly"*. Other students noted that the application of Scrum made classes more dynamic and practical, simulating the real work environment. One student reported: *"a more practical dynamic, simulating the real job market"*.

Additionally, the Scrum method facilitated communication between team members and allowed everyone to track progress. As one student stated, *"By making communication between members simpler and by having everyone keep track of progress."* In addition, Scrum helped to deliver group work in a short time, promoting organization and ease. One student mentioned, *"I think*

SCRUM mainly contributed to delivering group work in a short time, so the team was able to have a great development in a short time with a lot of organization and ease thanks to SCRUM."

Table 10: Student feedback - Question 06

To what extent did the application of SCRUM contribute to the dynamics of the classes and to the achievement of the learning objectives?
"high"; "yes, in my view, it contributed a lot to the dynamics in the classroom and to the achievement of my learning"; "On a high scale"; "in communication mainly there was an improvement, in coming up with ideas together mainly"; "a more practical dynamic, simulating the real labor market."; "That it is possible to see the product, to know in which part it is legal or not, always thus generating dynamic issues"; "Making communication between members simpler and making everyone follow the progress."; "I think SCRUM contributed mainly to delivering group work in the short term, so the team was able to have a great development in a short time with a lot of organization and ease thanks to SCRUM."; "It made the classes dynamic, forcing greater interaction between those involved."; "It allowed that throughout the development process, all members were situated that each was developing"; "I think it was very important for us to do a good job"; "Through the methodology, she was able to contribute to promoting efficient collaboration of team members, allowing quick adaptation and developing practical skills. Contributed significantly to the achievement of the learning objectives, providing an experience closer to the 'real world' of work."; " He brought something that can be used in the field of work to the classroom, giving us an experience with the method."; " In my opinion, the dynamics are division of labor, daily meetings and the follow-up also includes that."; " Sometimes it was a little confusing, but it worked well"; "It reduced the conversation and increased the result".

Source: author.

Students identified several aspects of Scrum that contributed significantly to their education. See Table 11. Many mentioned the importance of division of tasks and the assignment of positions. One student highlighted: *"jobs with assignment of positions"*. The improvement in communication and collaboration was another crucial point, as indicated in the answer: *in communication mainly there was an improvement, in coming up with ideas together mainly"*.

The practical experience provided by the method was highly valued. One student commented: *"The experience itself in using this method for development, since the vast majority of companies use this method"*. Another student highlighted the efficiency and agile mindset provided by Scrum: *"What contributed the most was the efficient collaboration and agile mindset. The direct application of the situations in real projects strengthened my understanding, while keeping the focus on communication and continuous adaptation improved my personal skills and my approach to the challenges faced in software development."*

Table 11: Student Feedback - Question 07

In your opinion, what contributed most to your training when using SCRUM in programming classes?
"jobs with assignment of positions"; "the division of tasks and on time acted the most"; "Companionship"; "in communication mainly there was an improvement, in coming up with ideas together mainly"; "Agility in processes, tactics for working with Scrum."; "I can't say"; "It allowed me to better understand each part of the work."; "Have a team positioning, and also know how to divide tasks that need to be executed, having a good plan so that you can complete something well prepared that needs to be delivered to someone."; "It created in me the idea of teamwork in the development sector. Before I didn't know what it was like."; " The experience in using this method for development, since the vast majority of companies use this method"; "yes"; "What contributed the most was the efficient collaboration and the agile mindset. The direct application of the situations in real projects strengthened my understanding, while keeping the focus on communication and continuous adaptation improved my personal skills and my approach to the challenges faced in software development."; " It showed how group work is in the corporate environment and how the SCRUM method can facilitate these projects."; " It facilitates many things such as ease with work, if you have difficulty it is a simple thing to contribute to help the team participant."; " The form of organization"; "Results of activities".

Source: author.

The students suggested several areas of improvement for the application of Scrum in programming classes. The clear definition of the roles of each team member was an aspect mentioned by several students. One student said: *"I believe that making clear the roles of each member of the group so as not to bring problems in the divisions of labor."* Others suggested the need for more careful selection of teams, ensuring that member workflows complement each other. One student noted, *"More thorough team selection, not necessarily people who already get along, but people whose workflows complement each other."*

In addition, some students proposed the active participation of the instructor in some Scrum sessions to provide new perspectives and ideas. As one student suggested: *"I think that some Scrum instructors could participate together with the team, it is not necessary to be all, but with the help of someone outside the group it can generate new visions, so the members do not get stuck in their ideas and can increasingly improve them"*. Others recommend more comprehensive initial training and balanced time management to optimize the experience with the method.

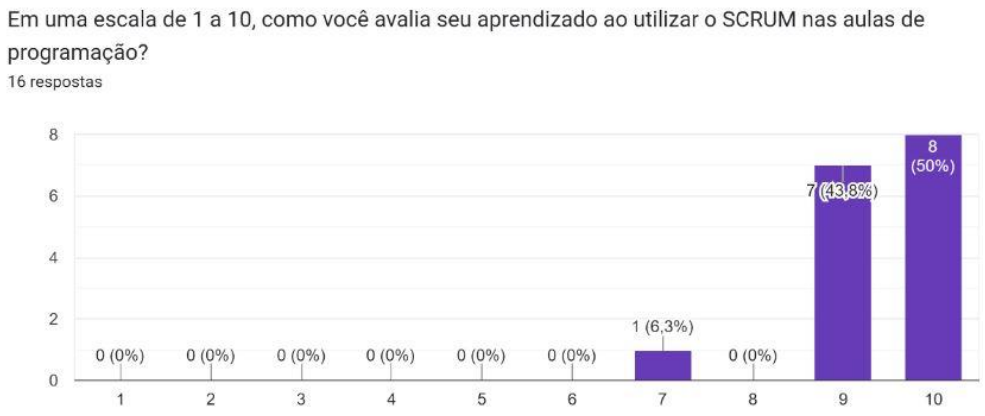
Table 12: Student feedback - Question 08

What are the specific points that you consider that can be improved in the application of SCRUM in programming classes?
"interaction with team members outside of prioritizing high-risk activities"; "I don't know in my view everything was well explained and with very good works"; "I think this method is good enough"; "in the decision of the leaders, who will be whom, etc."; "I can't say"; "In defining the role of each team member."; "I think that some SCRUM the instructor could participate together with the team, not being necessary to be all, but with the help of someone external to the group can generate new visions, so the members do not get stuck in their ideas and can increasingly improve them."; "A more thorough selection of staff, not necessarily people who already get along but people whose workflows complement each other."; "In addition to the collaboration of the entire team involved, specifically define the roles of the Scrum Master and the Po"; "knowing how to lead better"; "A more comprehensive initial training, balanced time management, evaluation and the possibility of integration with other agile methodologies. These improvements aim to optimize the experience and align SCRUM more effectively with the course objectives."; " I believe that making clear the roles of each member of the group so as not to bring problems in the divisions of labor."; " Thus, it could improve the team ideas more because there are cases where people do not accept the other's idea and go on. But not liking ideas is normal but they can improve instead of fights or conflicts between the team."; " oh I don't know"; "I don't know how to give an opinion."

Source: author.

The results obtained from the question "On a scale of 1 to 10, how do you evaluate your learning when using Scrum in programming classes?" reveal a largely positive evaluation of the use of this methodology. Among the participants, one person gave a score of 7, seven people gave a score of 9, and eight people evaluated with the maximum score, 10, as can be seen in Figure 4.

Figure 4: Assessment of learning through Scrum



Source: author.

The score of 7, despite being the lowest among the answers, still indicates a very favorable perception, suggesting that even those who may have encountered some difficulties or limitations in the use of Scrum recognized its educational value. The predominance of grades 9 and 10 demonstrates that most students considered Scrum extremely effective for their learning. The seven grades of 9 point to a near-perfect experience, suggesting that these students saw great value in the methodology, but perhaps identified small aspects that could be improved.

The eight 10 scores indicate that half of the respondents found Scrum to be a complete educational tool, which met or even exceeded their expectations in terms of learning and practical

application. This high level of satisfaction reflects Scrum's ability to engage students, promote better organization, collaboration and adaptability, essential aspects in the training of software developers.

However, it is important to consider some negative points and limitations of this evaluation. The sample of 16 students, while significant, could be broadened to include a greater diversity of contexts and experiences, providing a more comprehensive view of the effectiveness of Scrum. In addition, it is relevant to mention that students can sometimes respond to such surveys with biases, as pointed out by some authors. This bias can be a result of a variety of factors, including a desire to please instructors or a lack of comparative experience with other methodologies. Therefore, while the results are highly positive, it is prudent to interpret them with some caution and consider the need for additional studies to validate these findings in different educational settings.

FINAL CONSIDERATIONS

This article addressed a study with the objective of adapting the Agile Scrum Method to the educational context, specifically in programming disciplines of the Technical Course of Informatics for the Internet. For this, it was essential to understand the Scrum method in its original form and, subsequently, adapt it to the educational environment, including the curriculum and other specificities of the course. The experience report of a teacher was fundamental for this adaptation.

At the end of the project, three main results were obtained: first, the description of the adapted method; secondly, the feedback from the participating students; and, finally, the feedback of the participating teacher.

The proposed method proved to be viable for adaptation and use as a teaching tool in technical computer courses. The students' reports indicated that most perceived the use of the method as productive, highlighting the lack of commitment of some team members as the main challenge. The evaluation of the students revealed that most gave grades nine and ten for learning using the adapted method, with only one student giving a grade of seven.

The results were promising in the context and sample studied. However, for a safer evaluation, it is necessary to apply the method in other classes and with other professors, in order to compare the results obtained in this study.

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