

Application of Scrum and PM Canvas in a Project-based Learning Approach

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Abstract

Project-based Learning (PBL) is a teaching and learning strategy that allows students to develop competences while working on projects. It is important to apply good management approaches in order to achieve all project and learning objectives. This paper presents an application of Scrum and Project Model Canvas (PM Canvas) to manage learning projects developed by teams of students in interaction with industrial companies. These projects are part of a Project-based Learning (PBL) approach developed in the fourth year of an integrated master program in Industrial Engineering and Management. A group of 5 students from the fifth year of the same degree gave support to the PBL teams regarding the utilization of these tools. The work was developed during one month with meetings every Fridays. These project management tools were applied to help the PBL teams to organize and share the tasks, as well as visualize and control the whole project. To evaluate the teams' performance and the way they are realizing the tasks, it was counted the number of tasks done in each weekday and the students were inquired in order to understand their perceptions of the use of these project management tools. The results revealed that the groups performed most of the tasks on Wednesday and the inquiry revealed that most of the PBL teams did not know and had never used project management tools. The inquiry also revealed that the project management tools were considered helpful for the control and organization of the project tasks, improving overall team performance.

Keywords: Project-based Learning; Project Management; Scrum; Project Model Canvas.

1 Introduction

Nowadays, the engineering education all over the world is more focused in adopting teaching and learning methodologies more student-centered and where the student plays a more active and collaborative role in the learning process (Lima et al., 2014). These methodologies help students to develop competences (while learning) that are much needed in today's market. One of the most used methodologies for this is active learning (Lima, Carvalho, Sousa, Arezes, & Mesquita, 2017).

Active learning is a student-centered teaching methodology that actively involves and allows the students to put what they have learned into practice (Harmin & Toth, 2006). Active learning can be applied using several methods and one of them is Project-based Learning (PBL). PBL is an active learning approach in which students solve real problems through projects (Lima et al., 2017). For (Alves et al., 2015), teachers considered PBL positive as a learning approach. Student's motivation, engagement, a better understanding of the application of concepts in real-life situations were considered important outcomes for students when using PBL.

This approach is used in fourth year of the Industrial Engineering and Management, Integrated Master program, at University of Minho, Portugal, and it is offered in the Integrated Project II in Industrial Engineering and Management (IPIEMII) curricular unit. This PBL approach is developed in industrial environment, where students are challenged to try to solve real problems in companies (Lima et al., 2017). It lasts one semester, i.e., students are divided into teams and each team is allocated to a previously selected company. The good performance of the teams is very important for the success of these projects, and therefore, it becomes important to use project management techniques and tools to achieve the project objectives.

In PBL context, the quality of deliveries and the effectiveness of learning depend heavily on the project management adopted by the students, as well as on the project management skills of the elements that

compose the team (Almeida, Carrer, Carvalho, & Lima, 2011). Project management aims to predict problems and plan, organize and control activities so that projects are completed successfully despite all risks (Kerzner, 2017). A successful project management ensures that the project is completed on time, within the established budget and in accordance with the project specifications (Project Management Institute, 2017).

This article aims to evaluate the application of two project management tools in four IPIEM II teams, namely the PM Canvas and Scrum. These tools were applied with the help of a group of fifth year's students within the scope of Project Management and Lean Teams (PMLT), who during one month helped the teams to manage their projects and implement some improvements using these tools and adapting them to the type of project that the teams were developing.

2 Literature Review

There is currently a great trend on the way like the new ideas and strategies are put into practice in engineering. In most diverse areas of engineering, products, services and procedures are conceived through projects. This can be seen by the increase in the number of companies that are adopting project management methodology (Kerzner, 2017). Project Management is the art of coordinating activities in order to achieve the expectations of individuals and organizations directly involved in the project or those whose interests may be affected positively or negatively during the project or after its completion (Project Management Institute, 2017). Project management offers many tools that allow to divide the project into activities, work in a more balanced way and set short and long-term goals. Among these tools can be mentioned the Project Model Canvas (PM Canvas) and Scrum.

2.1 PM Canvas

PM Canvas is a project management tool that integrates all knowledge of the project, i.e., it allows to see all stages of the project, the objectives, the stakeholders and all other important aspects related to the project (Osterwalder & Pigneur, 2010; Silva & Cardoso, 2019). The main idea of the Project Model Canvas is to simplify and reduce the bureaucracy of the project management plan, through a visual model inspired by the Business Model Generation, in which the way to prepare a business plan is very clear through visual stimuli that allow processing fast and intuitive mental (Silva & Cardoso, 2019).

According to Finocchio (2013), the principles that guide the PMC are visual appeal, groupings made clearly, simplification, the concern to establish a base with stakeholders and the idea of sequence easily introduced by the visual appeal of the tool. In its design, there are four important steps to be followed by the Project Model Canvas, that are: *I. Conceive*: the components are grouped into six essential questions (Why, What, Who, How, When and How much), resulting in a sequence with a specific order; *II. Integrate*: then, it is necessary to validate the elements contained in the blocks, to relate them to each other; *III. Resolve*: stakeholders must find possible inconsistencies, points that deserve attention or inconsistencies in the design; *IV. Share*: finally, the canvas will serve as an official document or serve as a guide for the elaboration of other documents.

2.2 PM canvas in PBL

To prepare a project plan using PM canvas it is necessary to answer five questions as if we were applying the 5W tool shape.

2.2.1 Why?

At this stage, we justify carrying out the project, defining the objectives and also defining the future benefits of carrying out the project. In the first major justification, it is obviously the curricular unit for students and the objective is the delivery of reports. As for the justification in the company, these are the problems to be solved or even the opportunities for improvement. In relation to the objectives in the company, they need to be SMART, that is, Specific, Measurable, Attainable, Relevant and Timebound. The benefits are linked to increased productivity, increased profits, efficiency of machines and or of employees, well-being of employees, etc.

2.2.2 What?

This question defines the product that varies according to the company's activity and requirements. In the requirements, companies describe what they think is needed in the product or processes.

2.2.3 Who?

This is one of the most important questions. Here we define all the people involved in the Project and other external facts, from students' teams to external stakeholders, teachers and company representatives in the case.

2.2.4 How?

At this stage, we assume some premises, define restrictions and deliveries. In the premises we make assumptions taken for granted (i.e. every Wednesday the teams will be in the company, the sector where teams are working will always be in operation). Constraints are usually driven by assumptions and constraints; the idea is to always focus on relevant deliveries and component deliveries first. The restrictions are limitations imposed at work that diminish the options.

2.2.5 When and how much?

The last issue concerns "Risks", "Costs" and "Timeline". The risks are usually associated with uncertainties. For example, the team may go to the company where they are developing the project and become without work because that day the company is facing some urgency and the project receives less attention. The costs are directly linked to all the investment necessary to carry out the project, from transportation to the purchase of materials. Delivery times are dates when delivery is assumed.

After answering all these questions, teams are prepared to plan their projects using PM canvas (**Error! Reference source not found.**).

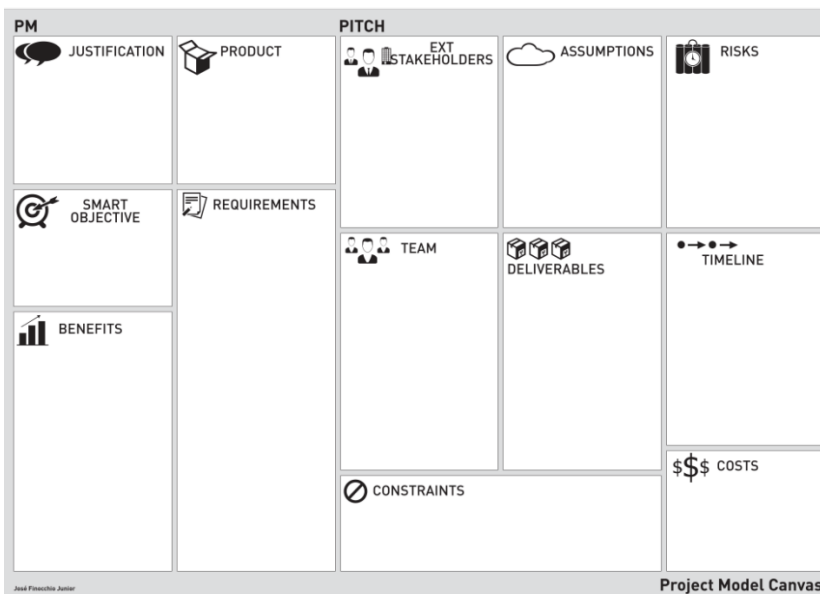


Figure 1. Project Model Canvas (Finocchio, 2013)

2.3 Scrum

Agile is a project management philosophy for collaborative working which consists of a set of values and principles that can be employed in any sector. Scrum is an agile methodology which is widely used in the software industry and thus in teaching (Naik, Jenkins, & Newell, 2020). As a project management tool it helps to define tasks to achieve project objectives set for short deadlines (Popli & Chauhan, 2011; Sutherland, 2014). These tasks are performed at fixed and pre-defined time intervals, these periods are known as Sprints. Sprint is considered the main practice of Scrum. It is the period in which the work items defined in the Product Backlog are implemented by the Scrum team. The Product Backlog is a list of activities that are likely to be developed during the project (Popli & Chauhan, 2011).

The Sprint Planning Meeting serves to define the product backlog. And at the end of each sprint, the Sprint Review Meeting takes place. In it, the team discusses their mistakes, alerts and issues learned. The person responsible for conducting these meetings and ensuring the fulfillment of activities, is called Scrum Master. Another important role in the scrum is that of the Product Owner. This team member usually represents the customer (internal or external). The Product Owner defines the requirements and the degree of importance and priority of each one (Sutherland, 2014).

The last artifact of Scrum is the burndown chart. It is a graphical representation of the remaining work compared to the work already done. Generally, the amount of work is placed on the vertical axis and the time on the horizontal axis. It is very useful for predicting when all work will be completed and for alarming the team in case of delay (which will be very apparent). Usually a line is drawn with the representation of the execution of the work. This line represents the effort already made in the execution of tasks. It is expected that the execution of the activities (tasks) will lead the starting line in Y to the meeting of X, that represents the end of the task executions (Popli & Chauhan, 2011).

2.4 Scrum in PBL

Scrum is an agile project management methodology. In the scrum, projects are divided into normally monthly cycles that are called sprint. However, due to the short term and the dynamism of IPIEM II projects, a weekly sprint was determined. To perform this sprint, the product owner must first define a list with all the features for the product and this list is called a product backlog.

During the Sprint planning meeting, the product owner prioritizes some product backlog requirements and describes them team development, these requirements are met for the sprint backlog. When doing this, the team breaks the product backlog into one or more tasks and with that the work is easily divided among the group members.

To coordinate the work, the scrum needs a scrum master, who during the first month were the fifth year's students.

2.4.1 Sprint Meeting

Every week the scrum master, the development team and anyone else interested in the project meet to define the tasks that are a priority for that week and assign to one or more team members (Figure 2).



Figure 2. Scrum Board (Upper and Lower Part, in portuguese).

2.4.2 Burndown chart

To monitor the progress, the team updates a burndown chart at the end of each sprint meeting. The burndown chart horizontal axis shows sprints; the vertical axis shows the amount of work that needs to be done at the beginning of each sprint. The work that needs to be done can be presented in a preferred unit of the team, in this case it is demonstrated in terms of scoring.

2.4.3 Sprint Review

At the end of every sprint meeting, a sprint review is done. During this meeting, the development team presents what was achieved during the sprint. During the sprint review the project is evaluated in relation to the sprint objectives, determined at the last sprint meeting.

2.4.4 Sprint retrospective

It is done at the end of each sprint to see what worked well, what worked poorly and what steps to take to improve.

3 Methodology

3.1 Project Description

To familiarize students with the challenges of the real world, the Integrated MSc in Industrial Engineering and Management introduced in its syllabus a curricular unit called Integrated Project in Industrial Engineering and Management II (IPIEMII), which is taught during the first semester of the course in fourth year. This curricular unit is supported by other courses of the same semester – Ergonomic Studies for Workstations; Integrated Production Management; Production Systems Organization II; Simulation; Production Information Systems. For more details in the dynamic of the course, please see (Lima et al., 2017).

For the accomplishment of this project, at the beginning of the semester students formed groups from 8 to 10 elements and are assigned to a company belonging to a list of companies presented by the university. The university collaborates with companies from different sectors, like textile sector, footwear industry, electrical and automotive, among others. The main idea is to solve problems of the various sectors of the company that use the type of industry, product or even the activity productive system type. So, the objective of this project is to identify, propose solutions and implement if time and the company allow it and, no less important, to improve the skills of teamwork, but always having as main base the other curricular units taught during the semester.

After the selection of the company, the team and one or more representatives of the company meet in order to define the team's working hours in the company, the team's workspace in the company, and make known the rules that govern that same company. The definition of the team's area of activity varies according to the company's need or availability. When the teachers idealized this project, it was part of the objectives for the companies to make a diagnosis, that is, to identify how it was mentioned in the project's objectives and to decide the area or areas of operation, but most of the time what happens is that the companies prepare in advance a problem to be solved by the teams (Lima et al., 2014).

The teams also have a space at the university that is granted to them to work when they are not in the respective companies and can also interact with the teachers in turn.

As a matter of monitoring and evaluation, teachers determine three delivery dates that serve as control points. The first date is expected as a result that the students present the identified problems and quantifying them, already on the second delivery date the preliminary solutions of the identified problems are expected as a result and finally on the last delivery date the students to present the proposals well-designed solutions and the results of their implementations if applicable.

In order to achieve all of these goals on their respective delivery dates with a large percentage of success with a dozen people on the team and so many other external stakeholders, it is necessary to have a well-defined plan. And to prepare the planning of this project, students use different types of project management tools, from the classic to the most modern ones.

PMLT team role The PMLT team, during one month, tried to share their project management experience with the PBL teams, in order to help them to overcome their difficulties in using project management tools for planning work, monitoring their performance and progress and also to ensure that after one month, the teams would be capable of using project management tools by themselves.

The implementation of the Project Management tools begun with the presentation of Scrum and PM Canvas to all the PBL teams, by a group of students from fifth grade who had already used it on the previous year. The fifth-grade group composed by the authors played the role of Scrum Masters (SM). In this presentation, SM

explained to the PBL teams how to use scrum and PM Canvas and agreed with them that weekly meetings would be on Friday's afternoons, as it was the only compatible schedule between the teams and the Scrum Masters. The number of tasks performed on each working day of the week was defined as a performance indicator for the job of PBL teams.

The weekly meetings took place for four weeks. The meetings usually started with an analysis on the PM Canvas, to define the next tasks and when they should be delivered. After that, the tasks performed on each working day of the week were counted and compared with the past count. The last phase of the meetings was reserved for the scrum ceremonies. The Figure 3 shows a filled scrum and PM Canvas by one of the PBL teams.

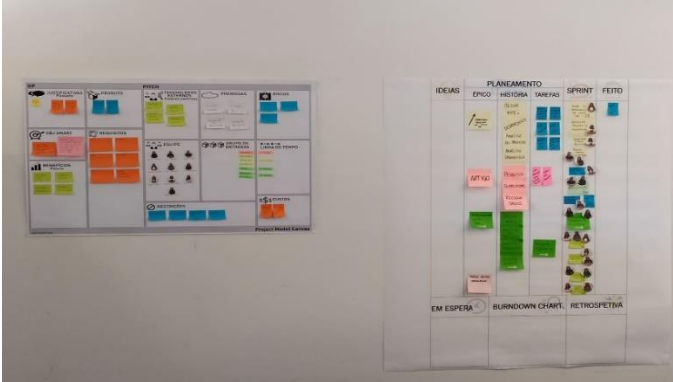


Figure 3. Scrum and PM Canvas filled at the end of one meeting.

In order to know the perspective of the PBL teams about the tools applied and the whole experience with the scrum masters, the PBL teams answered a questionnaire, with open-ended and closed questions in the following format:

- Have you heard of any project management methodology before this project? If so, which ones?
- Have you ever used SCRUM during a project before this project?
- Have you ever used PM Canvas during a project before this project?
- In the company where you are carrying out the project, do you use any project management methodology? If so, which one?
- Is there any project management tool you think would be more useful than PM Canvas or Scrum? If so, which ones?
- Do you feel that you could play the role of the project management in other PBL?
- Do you intend to continue using Scrum in this project?
- Do you intend to continue using PM Canvas in this project?
- How do you evaluate the Scrum Masters performance?

The questionnaire had a response rate of 75%, that is, 36 responses in 48 students. An analysis of all responses showed that they were all valid and will be presented briefly in the next section. The data presented in this article refer only to the four weeks of monitoring done by the authors.

4 Results

PMLT groups helped the IPIEM II groups to set performance indicators for their projects. In Figure 4, it is represented the average tasks performed by each weekday. It is clear that the day most dedicated for IPIEM II was Wednesdays, when the students had the whole day to dedicate to the project. On Fridays it is possible to identify some dedication, as Fridays' afternoons were also dedicated for tutoring by teachers and for group meetings. As the factors that lead to an unbalance of tasks at each day, pointed out by PBL teams and that caused this overload on Wednesdays are: precedence of some tasks, unavailability either by the company as by the teacher (tutor), need to go to the company to perform some tasks, lack of time and organization.

Although most tasks were performed on Wednesday, due to the factors already mentioned, students recognized the importance of using project management tools. This can be seen from the survey results. 76%

of respondents said they had never heard of project management methodologies before. 80% of respondents said they had never used SCRUM and 85% said they had never used PM Canvas. These answers can help to explain why there was some resistance from the PBL teams at the beginning of the semester.

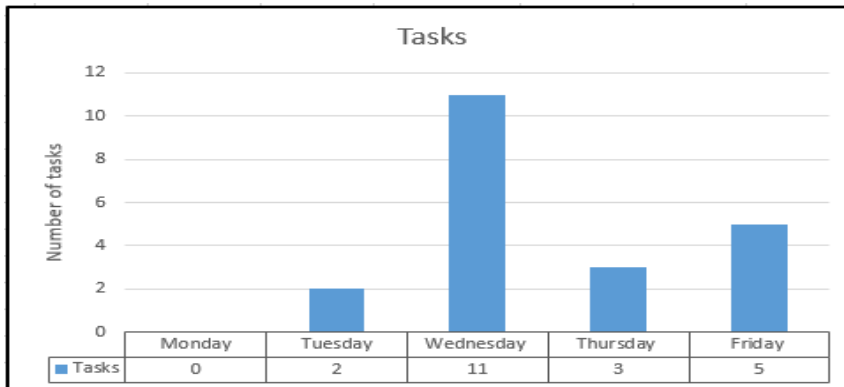


Figure 4. Average of tasks performed by all groups per weekday.

All respondents stated that no project management methodology was used in the companies where they were carrying out the project. As the weeks went by, the projects became more complex and the students looked for other tools and that is why 80% of the respondents pointed out that Trello® would also be a good tool for this context. (Naik et al., 2020) used a Trello-based agile Scrum methodology for teaching and learning purposes at no cost. Trello is a free project management and collaborative working tool, although it is not particularly designed for Scrum. However, the authors observed a significant improvement in overall performance and the Trello-based practical and collaborative working helped all students in understanding, clarifying and correcting their project activities in a timely manner. As a suggestion, this approach could be used in the future for the newcomer students of the next years.

At Table 1 are listed the main problems and solutions observed and reported by students.

Table 1 – Problems identified and tips for improvement, in students' views.

Problems identified	Tips for improvement
Too many tasks to be done on Wednesdays	More flexible classes schedules
Focus mainly on the closest deliveries	Pay more attention to PM Canvas and change Post-it®
Companies' resistance for the application of PM Canvas and Scrum	Incentive by companies to apply these methodologies

The feedback on the interaction with the Scrum Masters was very positive, as it helped the teams to make the most of their time; it provided a better control project tasks; improved orientation and organization of the teams; helped in solving problems within the group. The following excerpts, made by the students, underline the importance of this interaction:

"These methodologies helped a lot in the division of tasks and in time management." Narrative A.

"The Scrum Masters team was very clear in the way they transmitted their knowledge, and this made it easier to adapt to these tools." Narrative B.

5 Conclusions

Students from IPIEM complained about the time they have to dedicate to the project at the companies, because they have only one day to do it (in this case, Wednesdays), so they suggest having one more day to dedicate exclusively to the project. This way, they consider they could have more time to collect data at companies and

improve the project's outcomes. The class schedule and the lack of availability of teachers made it difficult to fulfill some sprints and caused many tasks to be performed on the same day.

The application of project management tools had a very positive effect on the way the groups organized the project. Despite the good results, the groups showed a lot of resistance to using these tools in the first meetings because they had never used similar tools. Bearing in mind that the project takes place in an academic and industrial environment, the companies in which the groups were inserted did not encourage the use of these tools and that was another factor that made the groups resist the application of these methodologies.

In general, the objectives of the project were achieved and allowed all students involved to develop various skills related to project and team management. It also allowed the exchange of experiences between students of different curricular years and this exchange of experiences meant that with this approach PBL teams did not make some kind of mistakes at the beginning of the project that could have had compromised the entire project.

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