Facilitating Problem-Based Learning in Teams with Scrum

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FACILITATING PROBLEM-BASED LEARNING IN TEAMS WITH SCRUM

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ABSTRACT
This paper discusses what design students gain from implementing project management practices from the Scrum framework within a project-organised and problem-based learning environment. Experiments with Scrum are carried out in student groups of a bachelor programme in Industrial Design and a Robotics and Automation Group at Aalborg University. The results of the research project indicate improved focus and team efficiency when using Scrum as well as significant improvements on internal team communication and attitude.

Keywords: Scrum, project-organised and problem-based learning, PBL, teams

1 INTRODUCTION

Project-organised and problem-based learning (POPBL) [1] is becoming increasingly popular across universities all over the world, and hence this, it is also gaining currency in some university-based design educations. At Aalborg University, the curriculum in Industrial Design engineering is no exception: Each semester, students are divided into groups and work with various problems or issues partly defined by themselves within the frame of the semester theme. The problem-based learning model encourages the students to take a rather active role in organising their own time and study activities. It also forces them to independently track down the specific literature and other sources needed in order to work their way around the given tasks and thereby meeting the learning goals of the particular semester.

During the first year at Aalborg University, students are taught how to manage and plan projects independently with the use of common planning tools like Gantt charts [2], schedules and simple resource management practices – tools, which are used throughout the education. However, this paper argues that these common project planning and management practices – typically representing rigid "plan-your-work, then work-your-plan" approaches – do not necessarily fit well to the often open-ended and wicked problems of design projects. *Scrum* [3], on the other hand, is a relatively new and agile management framework from the software industry that specifically addresses the need for more dynamic and flexible project management practices. Among other aspects, Scrum allows for midstream-changes and continuous revision of the project brief.

Questions about how elements from Scrum can be used to facilitate and structure the rather dynamic and often volatile process of designing in teams within a project-organised and problem-based learning environment therefore rise, and it is these questions that are initiating this research project. To support the project, experiments are carried out in student groups at the Industrial Design bachelor programme as well as in the Robotics and Automation Group at Aalborg University and evaluated through interviews with team members.

This paper partly builds on research presented on E&PDE'12 [4]. It discusses what design students gain from applying project management practices from Scrum to a project-organised and problem-based learning environment when trying to meet the learning goals of a design engineering curriculum. The outcome of the experiments supports an initial hypothesis about improved focus and team efficiency when using Scrum. But the experiments also reveal significant improvements on internal team communication and attitude. However, it also indicates possible limitations regarding the use of Scrum in some phases of the student projects.

The rest of the paper is composed as follows: The second section presents the background for the experiments in the form of a description of Scrum and its compliance with the characteristics of POPBL. Next, the third section describes the research setup and case data. Section 4 presents the

results of the experiments, and finally, the fifth section completes the paper through analysis and discussion of the results. Figure 1 below presents an overview of the elements brought forward in this paper.

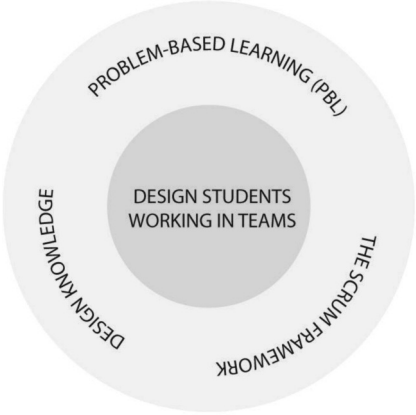

Figure 1. The correlation between PBL, Scrum, and the Industrial Design course

2 SCRUM AND ITS COMPLIANCE WITH THE CHARACTERISTICS OF PBL

Ken Schwaber and Jeff Sutherland originally developed Scrum for software development, and throughout the last 10-15 years, it has evolved into a widely used framework in this industry. In the latest edition of the Scrum Guide [5], Scrum is described as interplay between a number of roles, artefacts and events, which are all subject to a set of rules and presented in Figure 2.

Figure 2. The roles, events and artefacts of Scrum

When looking at Scrum in relation to project-organised and problem-based learning, several comparable principles seem to appear. In the 2004-publication *"Foundations of Problem Based Learning"* Savin-Baden and Major [6] list the characteristics of PBL:

- Complex, real world situations that have no one 'right' answer are the organizing focus for learning.
- Students work in teams to confront the problem, to identity learning gaps, and to develop viable solutions.
- Students gain new information through self-directed learning.
- Staff act as facilitators.

Scrum and PBL is unfolded and compared in the following subchapters according to these characteristics.

2.1 Not one right answer

As Savin-Baden and Major argues, complex real world situations with not one single answer are the point of origin in PBL. Likewise are Scrum and similar agile frameworks direct consequences of software and systems development tasks growing too complex for traditional development practices. Schwaber – one of the authors of the Scrum Guide – argues that complex problems are problems that behave unpredictably: *"Not only are these problems unpredictable, but even the ways in which they*

will prove unpredictable are impossible to predict" [3]. Schwaber further argues that Scrum is an empirically based process control framework that iteratively and incrementally allows development teams to dynamically build an answer or solution through continuous prototyping and evaluation. In this way Scrum facilitates a development process – or a learning process in an educational setting – that does not through a predefined scope narrow down the solution space to one single and potentially inopportune direction from day one. In contrast, Scrum allows the development team or the students to continuously revise the solution strategy throughout the project.

2.2 Team based learning and development

Project-organised PBL *can* be applied by individuals, but as in Savin-Baden and Major's definition above, it is most often carried out in groups of students working together on the same project. Development within the framework of Scrum is also very much a collaborative task. The Scrum Guide promotes cross-disciplinary teams as the heart of Scrum, and just as it is often the case in student groups, the hierarchical structure in a formal Scrum Development Team is flat. Everyone in a Scrum development team is anonymously titled "developer" in order to allow everyone to speak equally and thereby maintain a shared project commitment and responsibility.

2.3 Self-directed learning

As mentioned earlier, PBL puts a great deal of the learning responsibility on the shoulders of the students themselves, as the needed literature and other sources of knowledge for a given project is often not given prior to the project kick-off. Students direct their own learning by working with and understanding the problem statement of the specific project. They are thereby active in the knowledge acquisition and learn how to attack problems.

Scrum, in a similar way, promotes self-organising teams, which means that the management only *guides* the evolution of behaviours that emerge from interaction between individuals in the development team and not *dictating* a development strategy in advance. Instead, the development team collectively works out ways to best allocate its own resources in order to take advantage of the team member's individual competencies and strengths. In this way both Scrum and PBL encourage collective responsibility and participation in laying out the strategy for making the best of the available resources within the project framing.

2.4 Process facilitation, not project dictation

During a project and as a consequence of self-directed learning, it often happens that students become the experts over the supervisors, as they dive into a narrow, scientific area or acquire specific knowledge only relevant to *their* project. This leaves the supervisor in the role as a process facilitator rather than in the role of a "project dictator," making sure that progress and learning is taking place. This is much like the "Scrum Master" role, which has the responsibility of facilitating the Scrum process and educating the team to reach a high degree of awareness about their own process.

Elements of Scrum and PBL are outlined and compared in the sub-sections above. This brief comparative overview shows that Scrum is likely to support the PBL principles in regards to team organisation, hierarchical structures, and various project dynamics. Scrum furthermore promotes an experiential approach through iterative and incremental loops that to a large extent mimics the principles of the generic learning cycle suggested by Kolb [7].

3 THE CASE DATA

This paper builds its arguments on two separate cases. The first case (A) is a study of 3rd semester students from the bachelor programme in Industrial Design, and the second case (B) is based on a week-long experiment in the Robotics and Automation Group at Aalborg University. In both cases teams work in a PBL setting while applying elements from Scrum. None of the teams' procedures fully comply with Scrum, but only elements of it.

3.1 Research setup and methods

The two cases differ from each other in many ways. First of all, the one case concerns students in a typical learning situation, and the other concerns a research team that by their own initiative experiments with new methods for working together in a team. Furthermore, the student case is a rather longitudinal study as the data collection has been based on observation throughout large parts of

a full semester supplemented with interviews. The study of the research team in the Robotics and Automation group is only based on retrospective interview data.

3.2 The Student Case (A)

The overall 3rd semester theme revolves around mechatronic products, and all student groups are redesigning a robotic vacuum cleaner for private homes. The project is structured in four separate phases: *observation*, *concept development*, *product development*, and *detailing*. In the beginning of the project, the groups are encouraged to use some parts of the Scrum framework to structure and break down their work into smaller work packages as well as to organise their internal communication. These practices are then carried out, but it is first in the product development and the detailing phases that the groups seem to carry out the Scrum activities as a firmly rooted routine.

The groups primarily implement the Daily Scrum meetings and the concept of breaking down tasks into small and manageable tasks, but also the Scrum board, which is often used as a visual planning tool, supporting the Scrum framework, is implemented as a central element in the project management routines. It is observed and to a large extent validated through the interviews that the groups using the Scrum practices are working more efficiently in one common direction and in general seems less stressed by the project. Figure 3 below shows how one of the project groups is using a Scrum board to support their internal communication and task management.

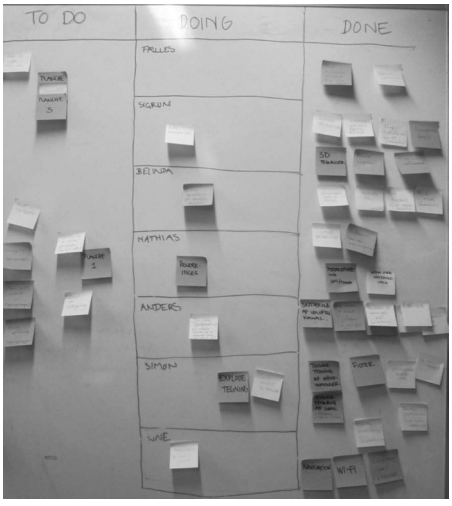

Figure 3. The Scrum board from one of the groups shows broken-down tasks and distribution of responsibility

3.3 The Research Team Case (B)

The second case revolves around an experiment in the Robotics and Automation Group. As a team building exercise and a way of promoting the work of the group, a weeklong project is initiated. The aim of the small project is to build a robot that is able to serve coffee to the team members on demand. The project involves six researchers, and the project is organised in a way that strongly resembles Scrum with one of the team members also facilitating the process.

The project has some clear learning objectives, which are written as three vision statements on a white board in the project room. These statements are leading the team's effort and are broken down into small tasks that are carried out individually. Due to the short timeframe, the team conducts two or tree daily team meetings in order to evaluate the progress and to update or revise the plan. The team works closely together in building prototypes of the various parts of the robot. At the end of the week, the team succeeds in building a coffee-serving robot, which is controlled by an app for an iPad and that is able to move around in the project room based on various sensor inputs and build-in software instructions. The robot is shown in Figure 4 below.

Figure 4. The coffee-serving robot Carlo

4 RESULTS

The two cases show that Scrum is successfully implemented into project-organised and problem-based learning-environments within the field of product design and development. This is despite the fact that Scrum is developed for software development in mind. The interviews carried out reveal that team members in both cases find that the elements of Scrum is strengthening and supplementing the project management practices and allowing the teams to work more efficient and focused. The integration of Scrum furthermore support and formalise the communication in the team.

In both cases, the teams do not fully comply with Scrum in all of its aspects while studying and working in the PBL-environment. However, Table 1 below shows that several elements from Scrum have been successfully applied to the two design and development projects.

Table 1. Compliance with the Scrum framework

Elements from Scrum	**Student Case (A)**	**Research Team Case (B)**
Daily Scrum Meetings	Yes	Yes (2-3)
Task breakdown	Yes	Yes
Experiential prototyping approach	Yes	Yes
Co-located team	Yes	Yes
Defined roles	No	Partly
Vision statements driving learning	Partly	Yes
Dynamic problem statement	Yes	No

5 ANALYSIS AND DISCUSSION

As it is seen in Table 1 in section 4 above, there seems to be a relatively high level of compliance with the Scrum framework in both cases. Taken into account the relatively limited knowledge about Scrum within the teams, this indicates that Scrum more or less serves as a natural extension of the PBL-principles and therefore a natural addition that strengthen the management of PBL-projects. It is, however, important to remember, that Scrum does not provide any particular guidance when it comes to specific methods or tools for supporting the design or learning activities. In that way, Scrum is more or less to be seen like an empty shell or structure that students (or practitioners) can build their knowledge up around or structure their design process against. In the student case, one group expressed that they were glad that the project had been divided into the four stages beforehand. They felt that Scrum provided a very useful day-to-day management tool, but it lacked considerations about longer-term planning. Even though this may be caused by the fact that the students weren't presented to the full Scrum framework, which actually include a stance or attitude towards long-term planning, it may show that Scrum may scale from project to project and in many cases supplements traditional management tools such as stage-gate models and milestones.

This paper has investigated and discussed the correlation between the Scrum framework and the PBL principles used in design courses, and through two separate cases, it has shown that project-oriented and problem-based learning environments may benefit from integration of various aspect of Scrum in order to strengthen the project management aspects, which is not a built-in part of PBL. The final aim of this paper is to initiate further discussion about how these two frameworks for respectively learning and management can assist each other.

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