ASSessment for Learning: Using Agile Project Management Methods in Second-Year Electrical Engineering Design Project

Robyn Paul
Schulich School of Engineering, University of Calgary
rm.paul@ucalgary.ca

Abstract – Assessment for learning and formative assessment practices have been shown to provide students with improved learning outcomes. Specifically, assessment for learning provides students with feedback that can be used to improve their future performance. This feedback loop is similar to the processes used in agile project management, where short iterations between product demos provide quick feedback to align the product with customer expectations. This paper will provide a case study of assessment for learning and agile project management being applied in second-year electrical engineering courses. The results show that students appreciated the learning opportunity that came with these activities.

Keywords: Assessment for learning, Scrum, Agile project management

1. INTRODUCTION

This paper discusses the use of agile project management methodologies to provide an opportunity for rich formative AFL activities as students progress through a second-year electrical engineering design project. The case study discussed in this paper is a second-year electrical engineering design project. A more detailed overview of the design and implementation of this course can be found in another publication [1]. This paper will provide an overview on literature in assessment for learning and application of agile principles in education. After providing a brief overview of the context, specific assessment for learning examples will be given, along with preliminary student reflections and feedback.

2. BACKGROUND

2.1. Assessment for Learning (AFL)

There is consensus that formative assessment for learning (AFL) methods are a high-impact instructional practice, and perhaps one of the most effective interventions to increase student learning [2]. AFL methods provide ongoing diagnosis and feedback about in-progress learning, through interactions between the learners, their peers and the teachers [3]. AFL can be described as an iterative and reflective feedback loop where progress towards the learning goals are monitored, and adaptations in practices are made to achieve those learning goals. This latter part is essential to AFL – the information provided to the learner must be able to affect their future performance within the context of the specific learning goal [4].

Lifelong Learning is the twelfth graduate attribute required as part of CEAB requirements (Canadian Engineering Accreditation Board). Often, Lifelong Learning is often viewed as an ominous attribute that is difficult to teach and measure [5]. However, AFL practices have been shown to develop self-regulation in learners which is a skill that helps to foster effective lifelong learning [3]. For this reason, it is important to consider how we can bring more AFL practices into engineering. Fortunately, agile project management, a software engineering methodology, is built upon similar principles to AFL.

2.2. Agile Project Management: Scrum

Agile methods were developed for use in software engineering, to allow for short iterations between product demos and quick feedback loops. However, principles from agile have been beneficial outside of software contexts, including application of agile to undergraduate engineering design projects. Agile principles can be particularly useful for helping students to prioritize the development of a prototype, when they usually would have waited until the last minute [6]. One specific technical in agile project management is called Scrum.

Simply put, “Scrum is an agile approach for developing innovating products and services” [7]. Multiple timeboxed iterations, called a Sprint and commonly two-weeks in length, support the development of the end-product. During each Sprint, the team completes pre-determined product components, including the designing, building and testing, where they are then reviewed with stakeholders to get their feedback. These agile processes allow continuous validating and comments to clearly align the product development with the customer expectations [8].

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frequently presenting a “final” product, the iterative feedback process effectively moves the product towards the goal.

Scrum application in industry environments varies widely, and generally all companies vary the principles of Scrum to fit their needs. One study of ten companies implementing Scrum found that all companies used variations of Scrum [9]. There are many different iterations of how Scrum can be implemented in industry and in the classroom. Both from this study, and from the authors’ experience, organizations do not conform directly to the Scrum principles and Scrum is most effective when modified to suit the specific context.

Specifically, for the context of this paper and the implementation ofScrum in our classroom, there are a few pieces ofScrum terminology that are important to understand: backlog, sprint, and retrospective. The backlog focuses on the features requested by the customer, and although it is not a “to do” list, it may resemble one. A sprint is a fixed-length iteration during which the sprint backlog items are turned into “potentially shippable product” to allow for critical and clear feedback on the progress. A retrospective occurs at the completion of a sprint to discuss and identify improvements to be incorporated in the next sprint. The intent is not to focus on team processes (rather than details or tasks), and to move forward with continuous improvement.

2.2.1. Agile Principles used in Education

Scrum can be implemented as a classroom activity across a variety of learning contexts. Sarang-Sieminski and Christianson [10] implemented Scrum in their engineering Capstone Design projects as a project management tool. In an upper-level Publishing elective, Scrum principles were adapted to help students better see themselves as collaborators and encourage professional communication [11]. One student in this course reflected, “[Scrum] is just a fantastic way to discuss the problems everyone has with projects and is a sort of safe place to admit that you are confused or have problems with an aspect of the course or project.” Students in other communications courses [11], [12] also found Scrum principles helped to increase team communication and reduced team conflict.

3. CONTEXT

At the Schulich School of Engineering in the University of Calgary, a pilot project was implemented where all five courses for second-year electrical engineering students were designed and delivered in an integrated learning stream (ILS) [1]. In the ILS, the material for all five courses was covered in a collaborative environment with content that connects the courses together (see Figure 1). Students were engaged to actively learn the material of all of the courses in more of a free-form way, putting the material in context of real-world situations. Specifically, this paper will overview two learning activities that were designed based on agile and scrum principles, and aimed to support assessment for learning techniques.

![Integrated Curriculm](image)

3.1. Audio Player Project and Agile

The ILS was structured with nine weeks of content, delivered through hands-on and active learning experiences, and ended with a 3-week integrated project. The project was the design, construction, and testing of a simple portable audio player, which could have application to e.g. allowing autistic children to express themselves easier. During the first three weeks of the semester, students were taught about the principles of Scrum project management, and this was used to support their project development. As students were learning the required material to build their audio player through their courses and labs, the project development was slower, and therefore there were two Sprints at 3-weeks in length. During the final three weeks, the project development significantly increased, and the Sprints were 1-week in length to provide the students with continuous feedback during their project build time.

Figure 2 and 3 below show the requirements of the first two sprints. Specifically, students were given clear guidance on the first sprint, with both the expected product to be delivered and the backlog items. For the second sprint, students were given the expected product, but were expected to determine their own backlog items. After each sprint, students were giving guidance on a retrospective discussion and reflection to have with their team.

![Audio Player Project and ILS](image)
3.2. Portfolio Assignments and AfL

Throughout the last month of the term, students were required to complete ten portfolio submissions with reflections on their experiences in the courses and in the project. Each submission had to include a text description (one paragraph) and an accompanying visual graphic. The following are some examples of textual prompts given on the assignment:

- What is one thing you learned in this course and how will you integrate it into your project?
- What is the most interesting or surprising thing you learned?
- What is one thing you learned about agile project management?
- What was your most memorable experience in the ILS group?

Each set of 3 or 4 submissions were due in draft 1-week prior to the deadline. Teaching assistants (TAs) provided feedback on the draft submission in order to give students a second chance to submit and improve their reflection. This formative assessment practice can be time consuming for the instructor or TA to give personalized feedback to each student, however it can provide students with an incredible learning opportunity. In this case study there were 34 students in the class.

For example, one student submitted an entry that was titled “Project Management” and was given the following feedback: Consider how you can make your titles for the courses more innovative and interesting for the audience. In their final submission, the title they used for this same entry was “Synchronous” because effective project management ensures a synchronized team while working towards a final goal. This change showed the student valued the feedback and learned to apply their innovative thinking to the title of their portfolio entry.

Another student received the following feedback from their TA: Your drawings are good, but they are quite detailed and technical. Often you have multiple graphics included in each of the entries. Would you be able to choose one of these instead of including all of them? Figure 4 shows their first and second submission, where there is a noticeable improvement in their ability to clearly and concisely communicate through graphics.

4. DISCUSSION

Through the examples given above, it is evident that there are parallels between the agile project management process and assessment for learning pedagogies. Both processes encourage frequent iterations on the product in order to receive timely and applicable feedback. This feedback provides students the opportunity to reflect on their learning and improve. In all learning, it is important to remember that the learning does not come from the experience, but rather from the reflection on the experience [14], and well-designed AfL activities provide opportunity for reflection and improvement.

When reflecting on the agile project management process at the end of term in their portfolio entries, students recognized the importance of the iterative process.

- “the iterative process taught me to give a specific time stamp to do a certain amount of work which is better management and greatly reduces stress”
- “agile project management has directed importance to keeping focus on how much work has to be achieved in the long run”
- “progress is made quickly and flexibly in order to meet project deadlines in a more frequent fashion”
- “the technique of carrying out work in the form of sprints has shone light on the significance of having flexibility in our designs”

Through these reflections, it is evident that students saw the values of agile project management as an assessment for learning practice to teach them project management, and time management skills.
5. CONCLUSIONS AND NEXT STEPS

Through this case study, it was shown that agile project management principles and formative feedback can be used to promote assessment for learning experiences. Through these AFL experiences, students were able to improve on their work, receive frequent iterations of feedback, and reflect on their learning practices.

AFL practices are limited by the resources required based on the size of the class. Future efforts will look at implementing innovative methods of AFL in larger class environments in order to achieve the same student learning objectives.

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