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GIFTS: Introducing Agile Process and Product Development in an FYE Course

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Abstract: Great Ideas for Teaching Students (GIFTS): This paper describes two activities developed for the pilot offering of a new first-year experience course for all engineering and computing majors in our college. The course is multi-disciplinary, with hands-on projects from several different areas. The course introduces engineering and computing design principles and practices, with a particular focus on an agile methodology. The first activity is part of the team building phase of the course, and it is a kinesthetic activity where students develop a process that satisfies constraints and meets an objective. The activity involves several sprints wherein the students measure their results, reflect, and improve their processes. It is adapted from an industry activity using balls; we use balloons because they are more cost effective and easier to store. The second activity is a team-based, computing-themed project where the students prototype an app for a humanitarian organization. The teams choose their topic from several provided lists (UN Sustainable Goals, for example), collaborate to create user stories ("as a [persona], I want to [do something] so that [a goal is achieved]"), develop functionality and wireframe mockups, then use free app simulation software to create an interactive app. Both activities are completed within a 2-hour classroom session (one session apiece). The first activity is assessed through an individual reflection essay about the student's experience in developing, refining, and participating in the process. The second activity is assessed via a team lab report that showcases the brainstorming process and end result.

Introduction

The course is a required 2-credit hour course for engineering and computing majors, typically taken by first year students in their first semester. The course meets twice weekly for a total of 4 hours each week and is intended to be an active learning/laboratory course to introduce students to disciplines (by department) in our college, as well as engineering basics and orientation to campus resources. An emphasis on group work pervades the course. Students are assigned to teams of 4 in the second week of the term and work with the same team throughout the semester. The first activity discussed below is intended to be a fun, team-building activity that introduces the notion of agile processes. The second activity discussed below highlights principles of software engineering without requiring students to do any programming. In addition, students are introduced to humanitarian causes that encourage them to consider how their major can contribute to social good.

Lesson 1: Agile Process Activity

Traditional design processes in engineering and computing follow a sequence of steps. The end goal of a design process could be a product or it could be a process. The steps to develop the product or process using a traditional approach usually start with comprehensive planning to be completed before proceeding to creation. In contrast, agile design and development utilizes repeated iterations of a shorter plan-create-test-revise process, called sprints. Agile principles and practices are used in many fields of engineering [1, 2, 3, 4], but especially in software development. The key learning outcomes for the class session are: why is agile used, characteristics of agile, and a team activity that simulates developing a process to achieve a goal using an agile method.

An activity called the Ball Game is used in industry [5, 6] to teach employees about sprints and developing agile processes. For the classroom, we adapted the activity to use 5-inch balloons, which are cheaper to purchase and don't require much storage space when not inflated. The students work with their assigned teams and complete multiple sprints. Each sprint has a 2-minute planning and estimating phase, a 2-minute iteration phase to carry out the process they design, and a 1-minute retrospective phase to suggest improvements to the process. We planned to carry out 6 sprints and record the results on the board for every team. The requirements for the process are as follows:

- the balloon must have air time between touches,
- the balloon must be touched at least once by every team member,
- the balloon can't be passed to a direct neighbor (right or left), and
- the first person to touch the balloon must be the last in order to complete one cycle.

Students estimate how many passes their team can complete, carry out their designed passing strategy while counting passes, and then reflect on what went well/poorly and how they can improve their process. They make another estimate and redo the activity.

After completing the activity, the entire class engaged a discussion about what did they learn, how did they make decisions, how important were the retrospectives, and how did the iterations differ. Each individual student was asked to reflect on what they learned by writing one paragraph that addresses the following prompts:

- What did you contribute to the team's process or results?
- What did you learn about agile methodology from participating in the activity?
- What did you learn about working with a team?

Lesson 2: Agile Software Design Activity

The course was designed to include a hands-on, mini-project from each of the four departments in our college. The computing area included a team-based mini-project to create an app using an agile development process and a rapid prototyping software tool. The students were assigned a pre-lab activity to complete before the lab session to become familiar with the software. For this activity, we chose proto.io [7]. The activity was completed in one two-hour lab session.

A short lecture on user stories introduced the notion of brainstorming from the point of view of a potential user of an app. Writing user stories helps to keep the focus on solving problems for people as well as collaborating to work toward an end goal [8, 9, 10]. User stories have the form: "as a [persona], I want to [do something] so that [a goal is achieved]." An example from a student project in the area of waterfowl habitat conservation is: "as a duck lover, I want to know what I can do to help preserve their natural habitats."

The team were instructed to find a topic related to social good, such as UN Sustainable Development Goals [11] or select from a list of 50 non-profit organizations and their mission statements [12]. Once they agreed on a topic, they wrote user stories related to that topic on post-it notes and organized them on the board. Each team also had to reach consensus on 3-4 user stories to implement. From there, they mapped their user stories to functionality and sketched wireframe mock-ups of the screens for an app to enact the functionality. Students took photographs of their user stories and wireframe sketches to document the brainstorming process. Once the wireframes were completed, the students used the proto.io software to create working prototype of their app. The final part of the team lab report was a link to their app. Figure 1 shows a wireframe mockup drawn on a whiteboard along with the team's screen captures of their working app prototype. The screens were linked together via the blue clickable areas.

The rubric for direct assessment of the lab report was worth 25 points with the following breakdown: names, title, description (5), initial brainstorming (5), wireframe sketches (5), and app creation (10).

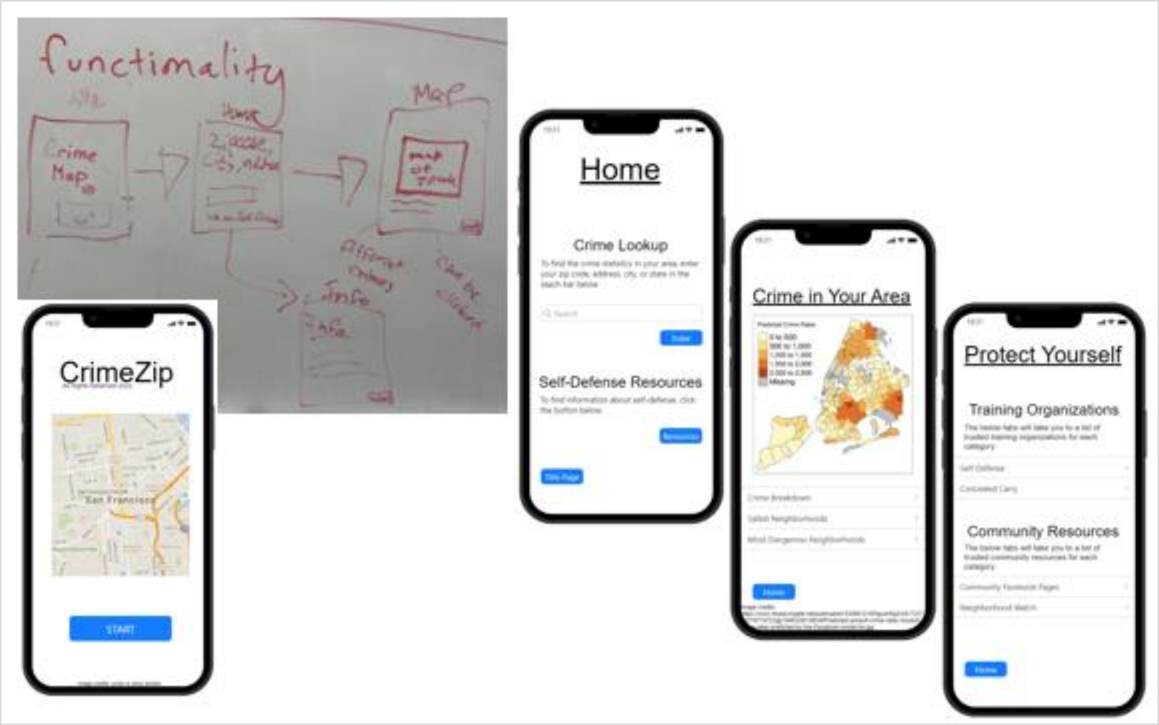

Figure 1. Documenting App Design

Results and Discussion

<u>Lesson 1</u>: It was a fun, high energy activity for the classroom. We adapted the lesson plan on the fly to use 3-4 iterations, and we combined the retrospective and planning steps after the first sprint. We also included considerations for students with latex allergies, vision or mobility challenges, or who were not comfortable performing a physical activity. We had these students act as process consultants and data collection specialists rather than active components of the balloon-passing process. In the assessment, most students grasped the importance of adaptability

and retrospectives in agile process development. A brief qualitative analysis over selected student essays identified some themes for each of the writing prompts:

- What did you contribute to the team's process or results?
    - active participation in the physical process
    - contributing ideas and/or revising the process
    - playing a specific role such as record keeping
- What did you learn about agile methodology from participating in the activity?
    - plan, test, and revise: quick and effective
    - identify and remove errors during repeated trials
    - benefits compared to non-agile design processes
- What did you learn about working with a team?
    - successful when every team member contributes
    - problem-solving together creates better solutions
    - importance of assigned roles
    - communication: sharing ideas and listening to others

In an anonymous survey, we asked the students how much they enjoyed various activities that occurred at the beginning of the semester, including this lesson. Of the 100 students enrolled in the course, 45 responded. For the question "How enjoyable or fun was the teamwork: agile process activity?" more than 75% of the students rated the activity at least "moderately enjoyable," with 49% of the students responding "very enjoyable." Using a scale with "very enjoyable" = 4, "moderately enjoyable" = 3, "a little enjoyable" = 2, and "not enjoyable at all" = 1, the average score for this question was 3.16.

Lesson 2: Students were engaged and on-task during the entire lab session. They really enjoyed the brainstorming aspects as well as the ability to create a working app prototype that could be shared with their friends and families.

The professional software (proto.io) was available for students to use during a free trial, but it had a few drawbacks. The most important one was that students could not share their projects, so they could not freely work on the app at the same time. Instead, the students worked one at a time on shared laptop to implement their screens. The downtime for other team members was utilized in putting the lab report together, but it would be preferable to identify app prototyping software that allows collaboration. A second drawback is that the developed app is unavailable after the trial period expires. We would include screen captures in the lab report instead of just requiring the link as we did in the first experience with this project.

In an anonymous survey, students were asked what they liked about the project and what could be improved. Several students mentioned that they enjoyed the project because it provided an opportunity to be creative without requiring coding experience. They suggested that the project could be extended to include more functionality and be more practical. In addition, the students could be asked to write a reflection about how they can use their major for social good in order to assess the impact of working with a humanitarian cause.

Conclusions

First-year experience courses in engineering and computing can leverage industry practices and tools to successfully teach agile principles in an engaging way with a low barrier to entry. Students do not need any prior programming skills to experience a facet of software engineering: agile design of processes and products.

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