Using GitHub as a Teaching Tool for Programming Courses

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Abstract

GitHub has become the most popular code management platform in the software development industry. It allows developers to manage their software development projects and collaborate with each other. Recently, educators also started using GitHub as a teaching tool for programming courses by hosting code samples and managing student assignments. In this study, we examine how GitHub is being used in academia, and we discuss the motivations and the benefits of using this platform. We also present authors' experience of using GitHub in programming courses of a software engineering program. We discuss the benefits and challenges of using GitHub and GitHub classroom in the classroom.

1. Introduction

GitHub is a Web-based code management and collaboration platform that allows developers to manage and collaborate across various software development projects. GitHub is open-source, free to use, and provides several collaboration features, such as access control, bug tracking, feature requests, task management, and wiki pages. These features enable developers to work more effectively together and provide a way for developers to control the changes of their code using version control systems, such as Git or Subversion (SVN). Git is the version control system that is most widely used across projects hosted on GitHub.

Git is a distributed version control system that allows developers to create multiple repositories and many branches. Subversion is another version control system similar to Git, but the major difference is that it is a centralized version control system which only allows one central repository to have the complete history of all the changes of the code. Developers using GitHub may choose between these two version control systems depending on the requirements of their projects.

GitHub is currently the most popular code management and collaboration tool in the software industry and many companies that develop software use it. GitHub is also used in academia as a teaching tool for software engineering courses [1]. Due to the popularity of GitHub, instructors have started to use it in their courses to publish course material, share code samples, and collect programming assignments. In this study, our objective is to examine how GitHub is being used in academia and discuss the motivations and the benefits of using GitHub in programming courses.

2. Use of GitHub in Education

2.1 As a Learning Management System (LMS)

In most education environments, LMS such as Blackboard or Canvas are used for hosting course material. GitHub has features such as creating wikis and posting documents that may allow it to be used as a limited LMS. However, it cannot be used as a full-fledged LMS as it lacks some necessary features of LMS including gradebook management, formal assignment submission, and plagiarism checking [1]. One of the recent features of GitHub is the capability to generate a website on GitHub server through GitHub Pages. GitHub Pages is a static site hosting service that could be used to publish course material. It supports all GitHub features allowing instructors to update the content and track versions. The interface allows instructors to publish content using traditional HTML formatting and use links as illustrated in Figure 1.

In most cases, GitHub is used in conjunction with a traditional LMS. There are mechanisms to access or integrate GitHub content into pages generated by an LMS. An easy method is to provide links to GitHub repositories or GitHub pages from course pages. A more challenging method is to integrate the content through JavaScript and HTML as most LMS provide an HTML editor. However, there are limitations and challenges to integration as some LMS do not allow all JavaScript code to run and also not all instructors would have the knowledge to perform such tasks.

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2.2 For Collecting Assignments

The most common use of GitHub in education is to collect student programming assignments. Many computer science and software engineering instructors recently adopted GitHub as a host for programming assignments [1]. GitHub is a more efficient platform for storing code than traditional LMS platforms. Students can post assignments easily by dragging and dropping source code files into their repositories and share them with their instructors. They can also modify the code with the built-in editor of GitHub when necessary. Advanced students typically use features such as branch and merge or perform pull requests. For instructors, management of assignments is an easier task with GitHub. They can access student repositories and see source files with fewer clicks than they do with a typical LMS. Instructors can provide feedback to assignments either directly in the source code using the code editor or typing their comments on the commit window as seen in Figure 2.

2.3 Collaborating in Team Projects

GitHub is a collaborative platform that can be used by student teams to share and comment on project artifacts. GitHub has been used in thousands of open source projects with success with it social media and collaboration functions [2]. For project or lab assignments, student groups can work on a public repository sharing code and ideas. It also allows cross-team communication with multiple teams working on a larger project as it happens in industry settings or teams exchanging ideas and reviewing each other's' work. GitHub allows the instructor and students to track the contributions of each member so students can be held accountable.

3. Use of GitHub in different disciplines

GitHub has been mostly used by professors and teachers in computer science and related areas. The majority of the repositories are used for storing programs. GitHub can also be used by instructors in other areas such as social sciences and law. The collaboration features would be useful for student projects and version tracking can be used to create project documents for individual or group projects. A GitHub repository is used to contain the United States Federal code [3]. The repository owner used GitHub to store the documents so the changes in the federal code can be published by contributors and be visible to all followers of the repository. The changes in the Federal Code can be also observed through version tracking. As GitHub gains exposure in different disciplines, it will not only be used in the realm of computer development. A recent work has been published on the use of GitHub by librarians and library science education by Davis [4].

4. GitHub Classroom

In 2015, GitHub released GitHub Classroom with the objective of streamlining the process of publishing and collecting assignments on GitHub [5] . This application serves as a user interface for instructors to publish their assignments in a virtual classroom they create and collect the assignments from student repositories. The process starts with the instructor creating a classroom page and creating assignment items. For each assignment, instructor sends an invitation link to students. Once the student accepts the assignment invitation, repository for storing the assignment is automatically created by the system. By default, these repositories are public, which means students can see each other's repositories. However, instructors that are worried about plagiarizing can request to use private repositories by sending their education credentials to GitHub.

5. Course experience with GitHub

The authors have been using GitHub for code management for several years. Last year, we published our work at the ASEE-GSW conference, on developing and hosting a Starter-Kit to teach web development skills. This package has been hosted on the GitHub repository: https://github.com/maangulo12/buildersrecords-example and shared with both graduate and undergraduate Software Engineering students in multiple courses. Students were able to clone this repository and started developing their own web applications successfully.

We also utilized GitHub for assignment management in two programming courses, EG 1305 – Object-Oriented Programming and Design, a freshman course and EG 3392 - Java and Applications, a junior course in the Software Engineering program. EG 1305 is a prerequisite for EG 3392, so all students had exposure to GitHub when they took this second course in the programming track.
In the first attempt to utilize GitHub for a course, almost all students were new to GitHub when they took EG 1305. They all had experience of submitting assignments through email or a LMS. We demonstrated the main functions of GitHub early in the semester: creating a repository, submitting files through the drag-drop mechanism, using the online editor, and adding collaborators. The students reacted positively to using GitHub instead of Blackboard, which was the LMS choice of the institution. Instructor also emphasized the use of GitHub in industry by showing a few job ads where GitHub skills were listed among the technical skills needed for software development jobs.

Many of the students kept using GitHub after this first exposure in EG 1305. The instructor observed that some of the students kept using GitHub for other courses and projects. Another benefit observed was the team

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collaboration in EG 3392. Students were given team assignments using the Java programming language for more advanced projects where they had to communicate and collaborate with each other throughout the semester. Some students were able to use more advanced functions of GitHub such as branching and merging. Some of them were also able to use their Integrated Development Environment, Eclipse, to connect to their GitHub account and submit their work directly from Eclipse. Another benefit was to see individual contributions of each student to the project. As the contributions were transparent to the instructor and all students, each project member felt they had to step up and contribute. Some of the students that used GitHub to share their professional portfolio when applying for jobs.

In Spring 2018, the instructor of EG 1305, decided to use GitHub classroom to manage the assignments. Before this semester, students were still using GitHub but they had to add the instructor as a collaborator for each assignment. For a class with 20 students, it was a challenging task to find the repository for each assignment for 10 to 15 assignments each semester. GitHub Classroom looks to be very promising to have access to all assignments on a single page as shown in Figure 3. The mechanism is also easier for the students as all they have to do is to accept an invitation link and submit their assignment. We will report the student experiences' of using GitHub classroom in a future publication.

There have minimal challenges of using GitHub in the classroom. The main challenge was students' unfamiliarity with GitHub at the freshman level. However, after the first two weeks, students became more comfortable using GitHub regularly. Instructor also had to use other mechanisms to collect students' work for major tests as the GitHub repositories used for the course were public.

6. Summary

GitHub has been used extensively by instructors for education. Based on GitHub's Octoverse website, over 500,000 students and 5,000 teachers are using GitHub [3]. GitHub classroom is also being used extensively to submit and collect assignments and it grew over 272,000 repositories [6]. In this study, we identified the benefits of learning how to use GitHub for computer science and engineering students. The utilization of GitHub also provides several opportunities for educators, such as creating a collaborative environment for project-based classes and better management of assignment collection for programming courses.

7. Future work

We are currently using GitHub in a freshman programming course and we will also be using it in Fall 2018 semester in a junior programming course. We are in the process of collecting information from students through surveys. We will be reporting our results in our next publication. Another study we will perform is to compare the student performances in these programming courses to their performances before we started using GitHub.

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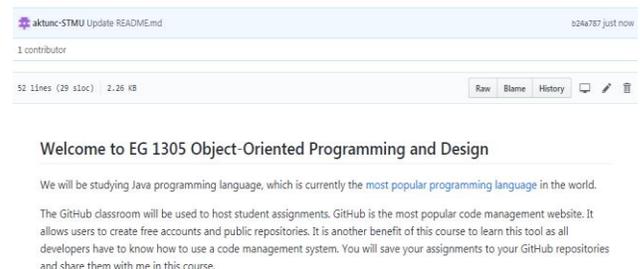[6] GitHub Octoverse, https://octoverse.github.com, (2017)

Fig. 1 A course homepage on GitHub pages

Fig. 2 GitHub code editor

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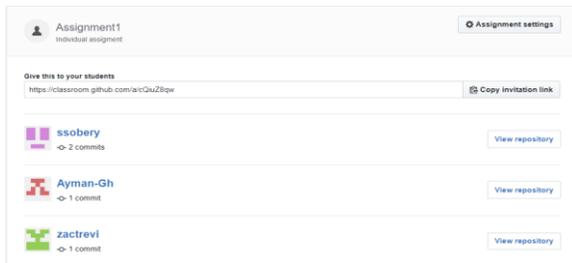*The University of Texas at Austin*
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Fig. 3 GitHub Classroom Assignment

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