Eliciting Course Feedback through a Bug Bounty Program

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ABSTRACT

In this paper, we present a bug bounty program that can aid instructors in systematically gathering formative feedback for iterative refinement of their course content. We describe the logistics of implementing the program, explain the types of content in which bugs are reported, elaborate on how students received the program, and evaluate if the program can be effective in improving the course quality. We present data from a large undergraduate Data Structures and Algorithms (DSA) course that was offered consecutively for four semesters. In total, 898 students enrolled in our course, 200 students reported at least one bug, and 373 bugs were reported in total related to incorrect or ambiguous content in instructional material, logistical errors such as broken links, and bugs in short programming problems such as less exhaustive testing. We found that a majority of the students who participated reported a single bug. We also found that the normalized number of bugs reported per student gradually decreased across semesters to almost one-half after two iterations (0.53 bugs reported/student in the first two semesters vs 0.28 bugs reported/student in the last two). This suggests that the program can be effectively used to iteratively refine the course content and improve the learner experience. Students received the program enthusiastically with 97% showing positive or neutral valence on the continuation of the program in future course offerings.

KEYWORDS

Course feedback, Formative feedback, Bug bounty

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1 INTRODUCTION

College courses are polished and improved across multiple offerings and instructors typically use summative feedback from the end of the semester evaluations to improve subsequent course iterations. However, often it is too late for students to remember errors in the coursework and state them in the end of semester feedback forms. In addition, in the context of large courses, systematically extracting feedback to polish the coursework is time consuming for instructors. We introduced a bug bounty program in our course to solve these problems and to allow the instructor (who is the first author) to elicit feedback as they transitioned into a faculty role as a new instructor.

Our bug bounty program is a feedback program where students can report unintentional errors in instructional content, confusing or ambiguous content, or flaws in any element of the course delivery. Some examples of a bug include an incorrect test case in a program, a broken link on the course learning management system (LMS), missing alt-text in a document, and typographical errors in a presentation or video. Our goal for this paper is to understand what types of content are affected by bugs, who reports them, how students received the program, and determine whether this program can help course staff in improving the course quality over multiple semesters. Prior work has explored the efficacy of feedback surveys to gather information on refining small courses [3] and web-based assignments [4] and have found that students give detailed feedback which can be used to refine coursework. Our work however discusses a simple and scalable technique in a different context of large courses which can be used to elicit feedback from students in any course. The technique is especially useful for new instructors.

2 STUDY CONTEXT AND LOGISTICS

Our bug bounty program was offered in the context of a large undergraduate DSA course at a public university in the United States. The first author who was also the instructor taught the course in Summer 2020, Fall 2020, Spring 2021, and Summer 2021. Summer 2020 was their first experience on teaching a large course. Our course is a required course for undergraduate students who are CS/CE majors or CS minors. The language of instruction is C++, and the course covers several topics such as algorithm complexity, trees, graphs, maps, and algorithm design techniques. The course was run in hybrid mode in Spring 2021 and in fully online mode in the other three semesters. Our course offered 4 credits and each week, students were expected to participate in three lectures and one discussion section which was led by a peer mentor. Also, students were expected to take a weekly quiz, two exams, two independent projects, and a final group project. Lastly, students practiced programming problems in which they implemented, used, or applied DSA concepts.

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Our bug bounty program was optional, but the students could receive up to 1% additional extra credit (EC) as a part of their course grade if they participated. Also, students had other options to avail the EC if they did not intend to participate. Students reported bugs on a Google form [2] with four open-ended prompts asking them the following: (1) Content (example: lecture video link, project 1 handout, etc.), (2) Error/bug description, (3) Name (optional, required for EC), and (4) Email (optional, required for EC). A limitation of our study is the lack of a control group and the results reported in the next section are based on observations in the data collected for our program.

3 RESULTS

200 unique students reported 373 bugs (after removal of 10 duplicates that were multiple entries of a bug by the same student) over four semesters and 113 of those students reported a single bug (see Table 1). The corpus for our analysis consists of 373 bugs which includes 66 duplicate bugs reported by different students (18% redundant bugs). This was because our students had no mechanism to identify if a bug was previously reported or resolved. In total, 30 bugs were reported multiple times by different students and a total of 307 unique bugs were reported. 197 students reported bug(s) for extra credit and three students posted bugs anonymously for no incentive. The bugs reported per student (Normalized number of bugs = Total bugs over a semester / class strength) shows a decline after Fall 2020 as new content was developed over Summer and Fall 2020 and minor changes were made over the next two semesters (see Table 2).

Table 1. Number of bugs reported per student

Number of Bugs	No. of Students (N = 898)	% Students
0	698	77.7%
1	117	13.0%
2	45	5.0%
3	18	2.0%
4	6	0.7%
5	7	0.8%
6	2	0.2%
7	3	0.3%
9	1	0.1%
11	1	0.1%

Table 2. Bugs reported across semesters

Semester	Course strength	No. of bugs	Bugs reported per student
Summer 2020	143	73	0.51
Fall 2020	333	179	0.54
Spring 2021	244	73	0.29
Summer 2021	178	48	0.27

Table 3. Frequency analysis of the type of content impacted by a bug

Category	Subcategory	Count (N=373)	Category Count	%
Assessments	Coding problem	68	158	42.4%
	Exam	9		
	Project	26		
	Quiz	55		
Instructional material	Poll question	3	155	41.6%
	Slides	66		
	Video	86		
Logistical	Logistical	51	51	13.7%
Other content	Others	9	9	2.4%

We inductively coded 373 open-ended responses to two-open ended prompts on content impacted and bug description using thematic analysis [1]. Due to lack of space, we will omit granular analysis of bug descriptions in this paper. Regarding the type of content, students reported bugs in four categories: instructional material (e.g., course slides, discussion slides, videos, etc.), assessments (e.g., exams, quizzes, projects, and coding problems), logistical elements (e.g., missing files, LMS page content, broken hyperlinks, date errors), and other content (e.g., course syllabus, books used in the course, external content, etc.). From Table 3, we can see that most bugs were related to assessments (42.4%), followed by instructional material (41.6%). At a more granular level, videos including live lectures had the most reported bugs (n=86), followed by programming problems (n=68), and slides (n=66). Instructors can use this information to allocate resources accordingly to iterate upon the content.

4 STUDENT RECEPTION AND CONCLUSION

As a part of an end of the term research survey, we obtained consent from students to use their data for research. 365 of the 476 students who were enrolled in our DSA course in Summer and Fall 2020 gave consent and completed this survey (Response rate: 76.7%). We used one of the open-ended questions to determine how students felt about our program: "*How was your experience in the bug bounty program? Should it be a part of future course offerings?*" We coded 50% of the 365 responses (n=183) into positive, neutral, and negative valence categories using content analysis [1]. The data selected was chosen at random. However, the dataset is representative of the larger dataset.

46% of 183 students (n=84) positively described the program and mentioned that it should be continued in the future. They also mentioned that extra credit incentivized them to participate. For instance, a student reported, "*Bug bounty was extremely helpful both for the students and the instructors I believe. Students could clear up any misconceptions and get extra credit in the process, while the instructor is notified of their errors.*" 51% of the 183 students (n=94) students expressed that they were neutral on program's continuation, or we could not infer what was a student's stance on the program. A majority of these students did not participate in the program. For instance, a student stated, "*I did not encounter any bugs to report, so I am neutral*". 3% of 183 students (n=5) stated that the program should be discontinued as they found it to be time consuming, distracting, or stressful. A student's response in this category mentioned, "*I do not think the bug bounty program should be a part of the course because it forces students to try to find errors and distracts from other things.*"

Given the positive reception of the program, we encourage that instructors adopt it in their courses to provide a better learner experience. We also recommend instructors to publish reported or resolved bugs so that students can search the repository before posting a bug that could be redundant.

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