Student Perceptions of Authentic Learning to Learn White-box Testing

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ABSTRACT

The pivotal role of white-box testing with respect to software quality assurance, necessitates dissemination of education materials related to white-box testing in the course curriculum. In this poster, we describe our experiences in conducting an authentic learning-based exercise related to white-box testing. From a conducted survey with 124 students, we observe the authentic learning-based exercise to be helpful for students to learn about white-box testing.

CCS CONCEPTS

• **Software and its engineering** → *Software verification and validation.*

KEYWORDS

authentic learning, white-box testing, student perception

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1 INTRODUCTION

Due to the importance of software testing with respect to software quality assurance [1], education-focused dissemination of testing techniques, such as white-box testing is crucial. White-box testing is a software testing technique that takes into account the internal mechanism of a software system [1]. Unlike black-box testing, in the case of white-box testing a software practitioner has visibility of the internal workings of a software system or a computer program [1]. Dissemination of education materials related to white-box testing can enable students to gather knowledge about white-box testing, and later apply the obtained knowledge in a professional setting.

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In this preliminary work, we describe students' perceptions about an exercise related to white-box testing. We develop the exercise using an authentic learning-based approach [4]. The exercise is deployed in a course taught at Auburn University (AU). Next, we use a survey to assess if students find the exercise helpful to learn about white-box testing.

2 RELATED WORK

Our paper is related with prior publications that have investigated instructional approaches to educate students on topics related to software quality assurance. Valle et al. [2] found game-based learning to be helpful for learning software testing. Rahman et al. [6] used authentic learning to educate students about secure development of Ansible manifests.

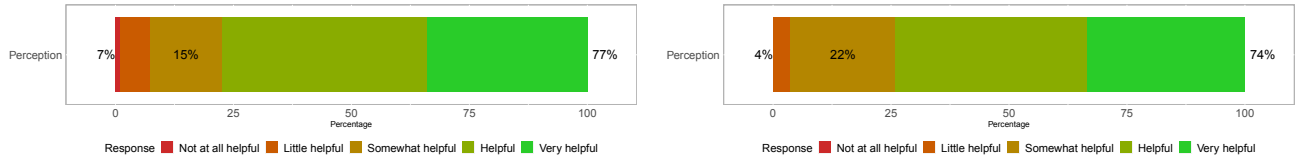
We observe existing research to study approaches to effectively disseminate topics related to software quality assurance in the course curriculum but a lack of research that focuses on instructional approaches to foster the learning of white-box testing. We address this research gap by investigating students' perceptions on authentic learning for learning about white-box testing.

3 METHODOLOGY

We take motivation from prior work [6] that used authentic learning for a topic related to infrastructure as code [5]. Our conjecture is that an authentic learning-based exercise can be helpful for students to learn about white box testing. We substantiate our conjecture by constructing an exercise using authentic learning, and then collecting student feedback for the conducted exercise. We *first* provide background on authentic learning. *Second*, we describe the conducted authentic learning-based exercise.

3.1 Authentic Learning

Authentic learning is an instructional approach that emphasizes on exposing students to real-world problem-based activities [3]. Curriculum modules developed using authentic learning include certain characteristics [4]: (i) focusing on hands-on exercises that have relevance to the real-world, (ii) allowing for students to have a diverse set of perspectives for the same exercise, and (iii) facilitating availability of resources to solve the exercises. An authentic learning-based exercise consists of three components: *first*, as part



a . Perceptions of undergraduate students

b . Perceptions of graduate students

Figure 1: Student perceptions of authentic learning to learn about white-box testing.

```
1 def divide(v1, v2):
2     temp =  v1 / v2
3     return temp
4
5 def fuzzValues():
6     '''
7     In-class Demonstration: expected software testing
8     '''
9     # checking if program works for 2 and 1
10    res = divide(2, 1)
11    '''
12    In-class Demonstration: unexpected software testing  to trigger
      ↪  a divison by zero exception
13    '''
14    # checking if program works for 2 and 0
15    res = divide(2, 0)
16    '''
17    Post-lab exercise: generate three more exceptions with the two
      ↪  inputs $v1$ and $v2$
18    '''
19    print(res)
20    print('='*100)
21
22 def simpleFuzzer():
23    fuzzValues()
```

Listing 1: Python program used to conduct the exercise.

of pre-lab content dissemination, necessary background is provided to students prior to conducting the exercise; *second*, as part of in-class experience, students are provided hands-on experiences within a classroom setting, so that students gain necessary hands-on experience by working on a problem that has real-world relevance; and *third*, as part of the post-lab activity, after the in-class experience is complete, students are assigned a post-lab activity, where the students solve a problem that is a variant of the in-class activity.

3.2 White-box Testing Exercise

The authentic learning-based exercise consists of three components: (i) pre-lab content dissemination, (ii) in-class demonstration, and (iii) post-lab exercise. *First*, as part of pre-lab content dissemination, the instructor provided necessary background on white-box testing. *Second*, as part of in-class demonstration, the instructor used a Python program that can perform division operations. The Python program is available in Listing 1. Availability of the program throughout the exercise enabled the instructor to demonstrate the internals of the program to the students. The instructor started with a simple implementation where `temp = v1 / v2` is used to perform division. Later, using the concept of white-box testing, the instructor demonstrated a 'Division By Zero' exception (line#11-#15). *Third*, as part of post-lab exercise the students are asked to generate three more exceptions with the two inputs $v1$ and $v2$ (line #16-#18). Once the exercise is completed, we ask the students to complete a survey, where we seek feedback on the conducted exercise. In the survey, we ask the following questions: (i) "*Which program are you enrolled in?*", and (ii) "*Did the workshop help you to learn about white-box testing?*". Answer to the first question is obtained using a textbox. The second question's answer is a five-item Likert scale with five options: 'Very helpful', 'Helpful', 'Somewhat helpful', 'Little helpful', and 'Not at all helpful'.

4 RESULTS

The exercise is conducted at AU for a course titled 'Software Quality Assurance' in Fall 2022 and Spring 2023. In all, we collect responses from 124 students of which 97 and 27 are respectively, undergraduate and graduate students. Figure 1 showcases the proportion of students who perceive the authentic learning-based exercise to be helpful. From Figure 1a, we observe 77% of the surveyed undergraduate students to perceive the authentic learning-based exercise to be 'helpful' or 'very helpful'. From Figure 1b, we observe 74% of the surveyed graduate students to perceive the authentic learning-based exercise to be 'helpful' or 'very helpful'. Based on obtained data, we conclude that authentic learning is perceived positively by students to learn about white-box testing.

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