Black Box Testing of SIPADI from Student Perspective Using EP and BVA Techniques

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Abstract. The Digital Learning System (SIPADI) is a learning platform that needs to be tested to check its functionality to ensure quality from the user's perspective, namely students. The purpose of this research is to assess the functionality of SIPADI by applying Black Box Testing method through Equivalence Partitioning and Boundary Value Analysis techniques. Testing was carried out on the main features of the system such as the login process, filling in attendance, and uploading assignments with various valid and invalid input scenarios. The Equivalence Partitioning technique was applied to divide inputs into categories that reflect normal and exceptional situations, while Boundary Value Analysis focused more on testing important values that could cause errors in the system. The results of the tests showed that SIPADI achieved an effectiveness of 92.85% for valid tests and 7.14% for invalid tests. Referring to the Ministry of Home Affairs R&D standard (1991), this level of effectiveness categorizes the system as "very effective". The system has a good ability to recognize and handle various types of inputs and operate according to predetermined specifications. The test method applied proved effective in assessing the functionality of the system from the end user's point of view without requiring access to the internal code structure.

Keyword— Black Box Testing, Equivalence Partitioning, Boundary Value Analysis, SIPADI, Digital Learning System, Functionality Testing

1. Introduction

The development of information technology encourages higher education institutions to adopt digital systems in academic activities to improve efficiency and service quality. One of the realizations of this digital transformation is the implementation of SIPADI (Digital Learning System) at Politeknik Negeri Medan. SIPADI was created as an online learning platform that supports teaching and learning activities, and serves as a bridge between lecturers and students in academic activities.

Software testing is a crucial step in ensuring the quality of information systems. By testing, developers can detect errors as early as possible and ensure that the system functions according to the desired specifications [1]. One technique that is often applied is Black Box Testing, which is a testing method that focuses on the input and output of the application without considering the internal structure of the program code [2].

This research aims to check the performance of SIPADI through the Black Box Testing method using the Equality Sharing and Boundary Value Analysis techniques. This method was chosen for its ability to find errors in user input without having to access the source code, making it suitable for testing

the end user experience [2]. Black Box Testing focuses on the inputs and outputs of the application, allowing testers to detect functional defects quickly and ensure the system operates according to expected specifications [1]. By combining these two techniques, the research is expected to identify potential errors at the input value boundary and verify that the system is functioning according to user requirements.

The scope of this research includes testing the main features in the SIPADI academic information system that are often accessed by students, such as login, viewing the course list, recording attendance, uploading assignments, accessing the academic calendar, and displaying assessment results. Testing the login function is done to ensure that user access is secure and appropriate. The course viewing feature is assessed based on the accuracy of the information about the courses displayed. The attendance filling test is conducted to ensure that the system is able to record attendance accurately. Assignment upload testing was conducted with various file formats and sizes to measure the reliability of the system. The calendar feature was evaluated based on the completeness and actuality of the academic information, while the grade display was tested to ensure that the calculation and presentation were accurate. Tests were conducted using test case scenarios involving valid and invalid data to assess the system's response in various situations, resulting in a comprehensive picture of the quality of SIPADI's functionality.

The benefit of this research is to provide experiential evidence on the functional quality of SIPADI from the students' perspective, so that the developers can correct possible errors before the system is used more widely. The results of this test can also serve as a reference for educational institutions in ensuring that their digital learning platform can support an effective and smooth learning process [3].

2. Literature Review

2.1. Academic Information System

Academic Information System is an important component in educational institutions that aims to facilitate the management of academic data digitally, such as student login process, grade filling, and file management. In the e-learning application, this system is tested through various scenarios to ensure the reliability of the login and file upload features. For example, testing the login with a combination of student NIM and password and uploading files with a maximum size limit shows that the system has run according to the initial specifications [1]. All 12 test scenarios were successfully executed, including login validation that rejected empty input and files that exceeded 50MB, proving that academic information systems can function optimally when tested with the right methods. This finding confirms that testing the main features of academic systems is crucial to ensure the quality of stable and reliable online services [1].

2.2. Black Box Testing

Black Box Testing is a software testing method that focuses on the functionality of the system without paying attention to the internal structure of the program code. This technique is widely used to test whether the system responds to input in accordance with the expected output. In research on the Edu Digital application, Black Box Testing is applied to test various login and transaction scenarios, including email input, password, and validation of numerical data such as balance and transaction amount [2]. By designing test cases based on use case diagrams, researchers managed to identify 21% of input validation errors, especially in the case of boundaries and blank data

2.3. Equivalence Partitioning

Equivalence Partitioning (EP) is becoming a key technique in Black Box Testing to categorize inputs into valid and invalid categories. A web-based e-learning application showed how this technique successfully identified errors by partitioning test cases based on certain criteria, such as student NIM and file size limit [1]. As a result, all 12 test scenarios ran successfully, proving that EP is able to validate system functionality efficiently. However, the weakness of EP lies in the possibility of missing critical boundary cases, especially in systems involving numerical value ranges.

2.4. Boundary Value Analysis

On the other hand, Boundary Value Analysis (BVA) is designed to test values around input boundaries, such as minimum and maximum values. For example, a student grading system found that the system still accepted values outside the 0-100 range (e.g. -1 or 101), resulting in a test success rate of only 80% [3]. These findings indicate that BVA is effective at finding gaps in input validation, but needs to be combined with other techniques to cover more scenarios.

3. Methodology

3.1. Literature Study

In the software development process, testing is an important step to ensure that the system built can function according to user expectations. One approach that is often used is the black box testing method, which focuses on the input and output of the system without looking into its code structure.

A study on web-based e-learning applications uses a similar approach, namely the Equivalence Partitioning technique, to ensure that the e-learning system can run optimally and free of errors that can interfere with the online learning process [1]. This research is important, especially in a time when distance learning is the main solution.

Meanwhile, another test applied Equivalence Partitioning to an employee payroll system. They utilized this technique to categorize inputs into valid and invalid classes, with the aim of ensuring that every input the system receives is truly appropriate for its function. This approach helps create a system that is more stable, easy to develop, and minimizes errors in the salary calculation process [4].

Through the various studies above, it can be concluded that the use of black box testing methods, especially with the Equivalence Partitioning and Boundary Value Analysis approaches, is very helpful in improving the quality and reliability of software, especially those used in education and web-based information systems.

3.2. System Requirement Analysis

The Digital Academic Information System (SIPADI) provides various key features designed to support student academic activities effectively and efficiently. These features include user authentication through the login process, access to the list of courses taken, recording attendance or attendance, uploading assignments by students, displaying the academic calendar to see the schedule of important activities, and visualizing the value of learning outcomes. Each feature has a specific function that aims to facilitate students in interacting with the academic system digitally [5].

In terms of functional requirements, the system must be able to provide secure and responsive login access, present real-time academic information, and allow students to manage their academic activities such as viewing grades, uploading assignments, and checking schedules without any display errors or system logic errors. Fulfillment of these needs is the main benchmark so that the system can meet the expectations and needs of end users, namely students [4].

This is in line with research that tests the Academic Information System application using the Black Box Testing method with the Boundary Value Analysis (BVA) technique. The study emphasized that input validation at the upper and lower boundaries is very important, because most system errors arise when receiving invalid extreme data. The test results on the application they studied showed that only about 60% of the test cases were successful, so it is necessary to improve the quality of the system, especially in handling input at the boundary and testing extreme usage scenarios [5].

3.3. System Requirement Analysis

In this phase, test scenarios were designed to test the capabilities of the Digital Learning System (SIPADI) by utilizing the Black Box Testing method which applies the Equivalent Division and Boundary Value Analysis techniques. These techniques were chosen to ensure that the test covers a wide range of possible input conditions, both true and false, so that the system can be thoroughly tested without having to look at the internal code structure.

Test scenarios were created based on the identification of equivalent groups of inputs received by each tested feature, such as the login, attendance filling, and assignment uploading features. Using the Equivalent Division technique, inputs are grouped into categories representing valid and invalid cases.

Furthermore, with the application of Boundary Value Analysis, testing is directed at critical values that are often the cause of errors in the system.

$$Valid\ Test\ Case = \left(\frac{a}{b}\right) \times 100\%$$

$$Invalid\ Test\ Case = \left(\frac{a}{b}\right) \times 100\%$$

To measure the effectiveness value, we use formula 1 to calculate the percentage of successful test cases. Here, variable a represents the number of valid or successful test cases, while variable b includes the total test cases performed. In addition, to measure the percentage of invalid test cases, formula 2 is applied. In the formula, the variable a fails, while the variable b becomes the total test cases that have been carried out [6].

To determine whether the application meets the criteria applicable in the community, the tester uses the guidelines set by Litbang Depdagri in 1991.

Table 1. Effectiveness Reference Standard

Effectiveness Ratio	Level of Achievment
Under 40	Very Ineffective
40 – 59,99	Ineffective
60 – 79,99	Effective Enough
Above 80	Very Effective

4. Result and Discussion

In an effort to ensure that the system operates in accordance with the planned functionality, a series of tests were conducted on several key features. These tests included logging in, completing attendance, and uploading assignments by users. Each test was carried out with various scenarios and input conditions to assess the durability and accuracy of the system in managing appropriate and inappropriate data.

The test results presented in tables 2, 3 and 4 below show the testing of the login, attendance, and assignment upload features.

Table 2. Login Page Test Results

Test ID	Scenario	Condition	Test Result	Final Result
EP1	Valid NIM and Password	Student's Valid NIM and Password	Success Go to the Dashboard Page	*Valid*
EP2	Empty NIM	**Valid:** Stay on Login Page **Invalid:** Go to the Dashboard Page	Stay On Login Page	*Valid*
EP3	Empty Password	**Valid:** Stay on Login Page **Invalid:** Go to Dashboard Page	Stay on Login Page	*Valid*

Tabel 3. Attendance Page Test Results

Test ID	Scenario	Condition	Test Result	Final Result
BVA1	Access before attendance time	Time: May 26, 2025 – 10:15 AM	Attendance menu appears, but status, points, and notes are not displayed	*Valid*
BVA2	Access during valid attendance time	Time: May 15, 2025 – 01:05 AM Status: Present	Attendance menu appears and attendance is successful	*Valid*
BVA3	Access after attendance time	Time: April 8, 2024 – 11:05 to 12:45 PM	Attendance menu appears, but status, points, and notes are not displayed	*Valid*

Table 4. Assignment Upload Page Test Results

Test ID	Scenario	Condition	Test Result	Final Result
EP4	Upload .pdf file on time	**Valid:** Upload successful **Invalid:** Unsupported file	Upload successful	*Valid*
BVA4	Upload .docx file exceeding 2MB	**Valid:** File exceeds maximum size (1MB) **Invalid:** Upload successfu	File exceeds max size limit (1MB)	*Valid*
BVA5	Upload .pptx file < 2MB	**Valid:** Upload successful **Invalid:** Upload failed	Upload successful	*Valid*
EP5	Upload .pdf after deadline (with permission)	**Valid:** Upload successful, status: Late **Invalid:** Upload failed	Upload successful, status: Late	*Valid*
EP6	Upload .pdf after deadline	**Valid:** Cannot upload **Invalid:** Upload successful	Unable to upload	*Valid*

Based on the test results shown in Table 2, it can be concluded that the login system has successfully managed various input conditions effectively. When the login data entered is appropriate, the system can take the user to the dashboard page. On the other hand, if the input provided is incomplete or invalid, the system will still hold the user on the login page, thus preventing unauthorized access. This shows that the validation process on the login page has operated as desired.

Table 5. Conclusion of Test Results

Scenario	**Total**	***Valid***	***Invalid***
Login	5	5	0
Attendance	4	4	0
Assignment Upload	5	5	0
See Course	2	1	1
Total	**14**	**14**	**1**

The process of calculating the effectiveness value in the SIPADI application of Politeknik Negeri Medan:

$$Test\ Case\ Valid = \left(\frac{13}{14}\right) \times 100\%$$
$$= 92{,}85\%$$

$$Test\ Case\ Invalid = \left(\frac{1}{14}\right) \times 100\%$$
$$= 7{,}14\%$$

Based on the calculations carried out, the SIPADI application obtained an effective value of 92.85% in valid tests and 7.14% in invalid tests, which shows a good ability to identify and handle.Based on the calculation of the effectiveness of the SIPADI application, the percentage of valid values from the various tests carried out reached 92.85%. Meanwhile, the percentage of invalid values from these tests is 7.14%. Overall, the effectiveness of the SIADITA application was recorded at 92.85%, which can be classified as highly effective based on the reference standard of Litbang Depdagri (1991) listed in Table 1.

5. Conclussion

Based on the functionality testing of the Digital Learning System (SIPADI) conducted by the Black Box Testing method using Equivalence Partitioning and Boundary Value Analysis techniques, this study indicates that the SIPADI application has a very satisfactory level of effectiveness. The system achieved a success rate of 92.85% on valid tests and only 7.14% on invalid tests. This level of effectiveness shows that the system has met the criteria of "very effective" according to Litbang Depdagri (1991).

The system's ability to recognize and cope with various types of inputs, both legitimate and illegitimate, shows that SIPADI has been designed with proper input validation. The application of Equivalence Partitioning and Boundary Value Analysis techniques proved successful in finding various test scenarios covering normal, boundary, and exceptional conditions on the main features of the system, such as logging in, filling attendance, and uploading assignments. The test results show that the main features of SIPADI work according to predefined specifications and can cope with various input conditions with a high level of accuracy. The Black Box Testing method with the applied techniques proved to be effective for assessing system functionality from the end-user's perspective without having to see the internal code structure, so that testing can focus on aspects of functionality that are relevant to students as system users.

While the SIPADI system has performed very well, there is still room for improvement, especially for the 7.14% of invalid cases. The researchers recommend that a more in-depth analysis of these cases be conducted to increase the robustness of the system to near peak effectiveness. The system also needs to be equipped with more informative and user-friendly error messages to help users understand the input errors that may occur. For future system development, implementing a comprehensive logging system will facilitate troubleshooting and monitoring of system performance in a production environment. In addition, performance testing should also be conducted to ensure the system is able to handle a large number of users, especially during peak usage times by students and lecturers.

Future research can incorporate other testing methods such as White Box Testing or Gray Box Testing to achieve a broader test coverage. Usability testing should also be conducted to assess the ease of use of the system from a user experience point of view, while security testing can be applied to ensure the protection of the system from various cyber threats. In terms of implementation, it is crucial to provide adequate training and documentation for end-users in order to maximize the utilization of SIPADI features. A robust backup and disaster recovery system needs to be implemented to guarantee the continuity of digital learning services. Continuous monitoring of the system is also necessary to recognize and resolve problems that may arise before they impact users, as well as creating a feedback mechanism from users for continuous improvement of the system based on real needs in the field.

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