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A Web Form Topic Implementation for PHP Web Programming Self-learning Support System

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ABSTRACT

Keywords
Code
PHP
Self-learning
Verification
Web programming
Web form

Web programming with PHP has surged in popularity due to the growing demand for dynamic web applications, with PHP's versatility and ease of use making it a top choice for developers. The importance of learning web programming has also grown significantly, leading to the incorporation of web programming courses in universities, colleges, and professional schools, as well as the rise of self-learning systems and online platforms that democratize access to web programming education. The development of self-learning systems for PHP web programming has been driven by the demand for web programming skills, incorporating Test-Driven Development (TDD) methodology and automated testing tools to create a comprehensive and effective learning environment. This study outlines the development of a self-learning system designed to teach PHP programming with a focus on building and managing web forms, a crucial skill for aspiring developers. It includes six key learning outcomes, offering students theoretical content and test code for hands-on practice and immediate feedback, following Test-Driven Development principles. In an evaluation with 33 Informatics Engineering students, 87.9% successfully completed the four learning modules within two hours, with module completion times ranging from 2 to 48 minutes. The feedback was largely positive, highlighting clear instructions and comprehensive materials, alongside suggestions for improvements like file accessibility and better code examples, demonstrating the system's effectiveness in enhancing students' PHP web form development skills.

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1. Introduction

Web programming with PHP has surged in popularity due to the growing demand for dynamic web applications across industries[1],[2]. As businesses increasingly adopt web-based solutions, PHP's versatility and ease of use make it a top choice for developers[3],[4]. PHP, a server-side scripting language, powers a significant portion of websites worldwide, including major platforms like WordPress and Facebook[5]. Its popularity stems from its simple syntax, extensive documentation, robust community support, and seamless database integration capabilities[2]. PHP's ability to create interactive and scalable web applications, combined with its open-source nature and vast ecosystem of frameworks, has solidified its position as a cornerstone of modern web development, meeting the diverse needs of both small businesses and large enterprises[6].

The importance of learning web programming has grown significantly due to the increasing demand for skilled web developers across industries[7]. Recognizing this trend, IT departments in universities and colleges have incorporated web programming courses into their curricula to prepare

students for the job market[8]. Similarly, many professional schools and coding bootcamps now offer specialized web development programs to cater to career changers and professionals seeking to upskill[7]. The rise of self-learning systems and online platforms has further democratized access to web programming education, allowing individuals to learn at their own pace and tailor their learning journey to their specific needs. This combination of formal education and self-directed learning opportunities reflects the critical role web programming skills play in today's technology-driven economy and the growing need for a digitally proficient workforce.

The growing demand for web programming skills, particularly in PHP, has driven the development of self-learning systems that leverage flexible platforms like Learning Management Systems (LMS) and Massive Open Online Courses (MOOCs). These self-learning models incorporate the Test-Driven Development (TDD) methodology[9], which aligns with the problem-solving approach used by software developers. TDD enables students to actively engage with coding concepts by writing tests before implementing the necessary code[10]. The use of automated testing tools, such as PHP unit, facilitates code verification and provides students with immediate feedback on their solutions[11]. This real-time feedback mechanism empowers learners to independently identify and address errors, fostering critical thinking and problem-solving skills essential for web programming[12]. The combination of self-paced learning, the TDD approach, and automated testing creates a comprehensive and effective learning environment for individuals seeking to master PHP web development[4].

This study presents the development of a self-learning system focused on building and handling web forms in PHP programming. Web forms are a fundamental component of interactive web applications, making the mastery of this topic crucial for aspiring PHP developers. The self-learning system outlined in this work contains six key learning outcomes, guiding students through the essential skills required to create and manage web forms effectively. The learning materials provided include not only theoretical content but also test code for code verification, enabling students to actively engage with the subject matter and receive immediate feedback on their implementations. This approach aligns with the principles of Test-Driven Development (TDD)[9], empowering learners to develop a problem-solving mindset and hone their critical thinking abilities.

The evaluation of the PHP web form learning topic was conducted with 33 students from the Informatics Engineering Program, who completed four learning modules over two hours. The results showed that 29 out of the 33 students (87.9%) successfully finished the assignments, with the fastest completion time being 2 minutes for the introductory Module 1 and the longest 48 minutes for the more complex Module 4. The students' feedback was generally positive, praising the clear instructions and comprehensive materials, while also providing constructive suggestions for improvements, such as enhancing file accessibility and code examples. The evaluation demonstrated the effectiveness of the self-learning system in guiding students through web form development in PHP.

The organization of this paper consists of: Section 2 lists some studies relating to this paper, Section 3 provides an explanation of basic concepts PHP Web Programming. Section 4 discusses the self-learning model, including the structure of learning topics and the application of automatic assistance. Section 5 outlines the implementation of the web form learning topic, covering learning outcomes, practical case studies, and learning assignments. Section 6 evaluation implements the PHP Form topic with automatic correction in testing feedback. Section 7 discusses the results related to the effectiveness of the self-learning system in helping students independently. Finally, section 8 presents a comprehensive conclusion with future works.

2. Related Works

Research by S. Said has demonstrated that the use of technology can improve learning effectiveness and student participation[1]. This study employed a qualitative approach, utilizing a literature review to analyze the role of digital technology as an educational tool in the 21st century. The study identified and analyzed more than 20 articles, revealing that technology plays a critical role in improving quality, accessibility, flexibility, effectiveness, interactivity, and student engagement in learning. The findings of this research have significant implications for educators and policy makers in the effective integration of technology to enhance the quality and effectiveness of learning and student engagement.

In 2021, Syaifudin et al.[13] conducted research on an online platform to learn Android programming using test-driven development. When a student submits a new answer, a server validation application automatically executes the validation test codes. Teachers and students can view the validation results using a web browser. 60 students evaluated this research, and their evaluations of its usability, performance, and functionality were favorable. The results also indicated the platform's reliability, compatibility, effectiveness, resilience, accessibility, security, and ease of use.

Mekterović et al. developed the Automated Programming Assessment Systems (APAS) application. APAS was created to address the challenges of manually grading programming assignments by providing objective, efficient assessments, and timely feedback. This study reviews the literature and the APAS software, identifying key features to support all stages of assessment in computer science courses. Despite numerous publications, the software options remain limited. Edgar, an open-source APAS developed over three years, supports multiple programming languages, multiple choice questions, exam monitoring infrastructure, and data analysis and visualization. Edgar is actively used in eight courses and continues to be developed with new features, serving over 1,000 students per semester[14].

On the other hand, research by Paiva et al. in 2020 focused on the types of exercises supported, security measures implemented, testing techniques employed, the types of feedback generated, and information provided to teachers to help them understand and facilitate learning optimization[15]. They emphasized that practical programming skills are crucial for computer science education and postgraduate preparation, requiring significant time for independent programming activities, which makes it challenging for teachers to assess each student in detail and fairly. As a result, automating the review process becomes essential. A new era of automated evaluation was identified using static analysis and containerization techniques, and various challenges and future research directions were discussed.

Similarly, research by Barra et al. (2020) describes the transformation of programming course assessments in higher education to fully online formats during the pandemic through student-centered automated assessment tools. The evaluation of student interactions and perceptions showed highly positive results, with the majority of students expressing a preference for using the tool and a desire for its application in other courses. This study also discusses the sustainability of this new assessment method in the coming years[16].

3. Method

3.1. PHP Web Programming

This section covers an explanation of basic programming, as well as web form handling and form validation within the scope of PHP programming.

3.2. Overview

Hypertext Preprocessor, or PHP, is a popular open-source server-side scripting language that is mostly used for web development but may also be used for other types of programming. Rasmus Lerdorf created PHP in 1994[17], and because of its syntax, it is very simple to learn for people who are familiar with C, Java, and Perl. PHP is run on the server and provided to the client as plain HTML after being embedded in HTML code[18]. Because of this, PHP is extremely useful for handling sessions, building dynamic websites and apps, and interacting with databases, especially when combined with WordPress, Joomla, and Drupal[18], [19].

PHP has several advantages, including being a large and supportive community, a wealth of tools and frameworks (like Laravel and Symfony) that improve development productivity, and thorough documentation[20]. With the release of PHP 7 and later versions, which have features like type declarations, additional operators, and better error handling, it has substantially improved in terms of performance, leading to faster execution times and better resource management. Due to its broad ecosystem, the affordability of compatible hosting services and the ease of deployment, PHP is one of the most widely used languages for online development. PHP is frequently included in computer science and information technology courses in collegesphp[21]. These curricula typically emphasize

web development, server-side programming, and database interface, giving students the hands-on experience they need to create safe and effective online applications.

3.3. Features of PHP

PHP is one of the most popular server-side scripting languages for web development, and its popularity can be attributed to several key features:

1. *Ease of Learning and Use* : PHP has a simple and easy syntax that matches closely C, making it easy to understand for novice users. Several developers find it straightforward to rapidly begin constructing web applications using PHP;
2. *Open Source and Community Support* : Being open-source means PHP is free to use and has a large community contributing to its development. This results in a wealth of resources, libraries, and frameworks available to developers;
3. *Integration with Databases* : Database integration is strongly supported by PHP. Its ease of connectivity to a wide range of database systems, including Oracle, PostgreSQL, MySQL, and others, is essential for developing dynamic online applications;
4. *Server-Side Scripting* : PHP is an effective tool for creating intricate online applications because it is mainly used for server-side programming. Websites become interactive when they process user requests and create dynamic page content;
5. *Cross-Platform Compatibility* : Because PHP is interoperable with almost all server environments and operating systems, developers may easily deploy apps on several platforms;
6. *Large Standard Library* : The extensive standard library offers numerous modules and functions for file management, database access, session management, and more, allowing developers to build applications without reinventing the wheel.

3.4. Importance of Learning Web Programming

The demand for digital skills in today's labor market has led to a considerable surge in the popularity of web programming in professional institutions and universities. In light of the increasing reliance on online platforms for business operations and communication, there is a pressing demand for skilled web developers capable of designing, managing, and improving these digital interfaces. The rapid advancement of digital transformation, particularly emphasized by recent global events like the COVID-19 pandemic[8], has emphasized the crucial importance of web programming skills[22]. Academic establishments are acknowledging this pressing need, resulting in the creation and enlargement of extensive web programming courses designed to equip students with the skills necessary for well-paying and highly sought-after jobs in the technology sector.

PHP is a highly prevalent server-side scripting language that is of significant importance in numerous university web programming courses. Its seamless interaction with HTML and databases makes it a popular option for instructing aspiring web developers[23]. Universities often provide a diverse range of courses aimed at providing students with a strong foundation in web programming. Some course titles such as "Web Development Primer," which covers a broad range of web technologies; "Comprehensive PHP Training," which offers a detailed understanding of the PHP language; and "Advanced Web Development with PHP and MySQL," which integrates server-side programming and database management expertise. The implementation of this methodical approach in higher education not only improves the likelihood of students finding employment, but also aligns with the changing requirements of the technology industry.

4. Results and Discussion

4.1. Self-learning Model

This section explains the self-learning model, the structure of learning topics, and the application of automatic assistance in this context.

4.2. Adoption of TDD Method

Computer programming self-learning systems are characterized by their flexibility, learner-centered approach, and integration of theory with practical application[24]. These models allow

students to customize their learning experience according to their preferences and goals, offering a variety of resources such as online courses, tutorials, books, and coding exercises[25], [26]. The hands-on approach encourages active engagement with the subject matter, fostering the development of practical problem-solving skills essential for real-world programming challenges. Key features of these systems include a comprehensive yet adaptable curriculum, access to real coding environments, continuous feedback, and regular assessments to track progress and identify areas for improvement.

The adoption of Test-Driven Development (TDD) methodology further enhances the learning experience by creating a structured environment where students engage actively with coding concepts[10]. In this approach, learners begin by analyzing specific requirements and writing tests before implementing the actual code[9]. Teachers facilitate this process by preparing automated testing tools with pre-defined test suites. Students then write code to pass these tests, receiving immediate feedback on their solutions. This iterative cycle of testing, coding, and refactoring not only helps ensure clean and well-organized code but also promotes independent problem-solving and critical thinking skills. By continuously refining their implementations based on test results, students develop a deeper understanding of programming concepts and best practices, preparing them for real-world programming challenges.

4.3. Automated Testing Tool for PHP-based Web Application

Automated testing tools are essential for ensuring code quality and optimizing productivity in PHP-based web application development[27]. PHPUnit, a widely used tool developed by Sebastian Bergmann in 2004, is specifically designed for unit and integration testing in PHP applications. It provides developers with a platform to create test cases and assertions, supporting test-driven development (TDD) and allowing for the validation of code behavior. PHPUnit enables developers to generate test cases using classes that inherit from its fundamental testing class, typically 'PHPUnit\Framework\TestCase'. These test classes contain methods designed to verify the expected results of various functionalities within the application, offering comprehensive feedback on test success or failure.

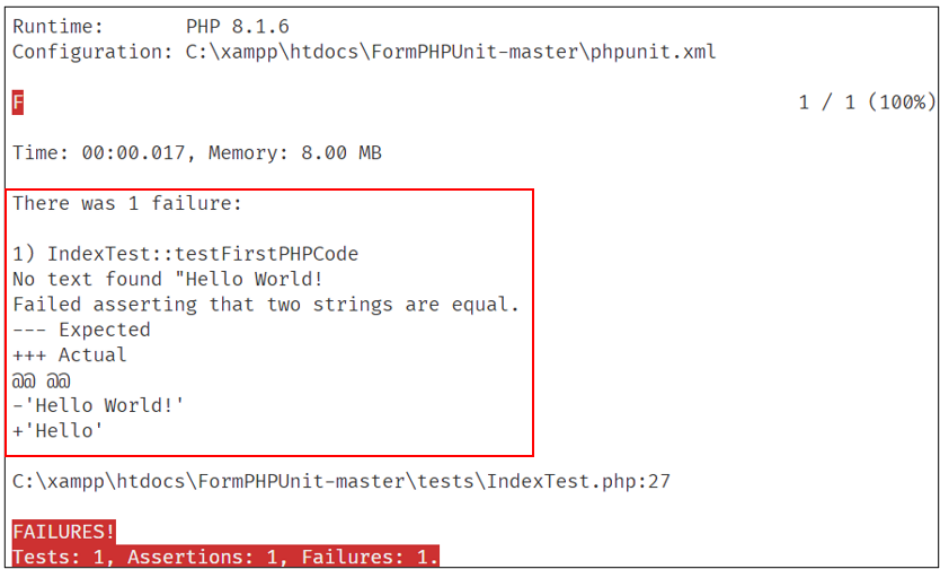

Fig. 1. Learning process on the self-learning model for PHP web programming

Code verification using PHPUnit involves both unit and integration testing, along with assertion methods, to provide instant feedback on PHP applications[28]. Unit testing focuses on verifying the isolated functionality of individual components, while integration testing assesses the interactions between modules to ensure seamless operation. Assertion methods help validate expected outputs, giving immediate insights into the correctness of the code[29]. This real-time feedback mechanism not only aids in rapid error correction but also promotes independent self-learning. Developers can install PHPUnit using Composer, set up a separate directory for tests, and execute them either through the command line or using a compatible integrated development environment (IDE). By improving the testing process and promoting best practices in software development, PHPUnit has become a crucial tool for PHP developers.

```
Runtime:       PHP 8.1.6
Configuration: C:\xampp\htdocs\FormPHPUnit-master\phpunit.xml

.                                                                   1 / 1 (100%)

Time: 00:00.009, Memory: 6.00 MB

OK (1 test, 1 assertion)
```

Fig. 2. Learning process on the self-learning model for PHP web programming

Figure 1 illustrates that if there is a discrepancy between the expected and actual results (assertion process) during testing, the system will generate an appropriate error message and provide corrective instructions for the identified issue. Conversely, a "passed" result will appear as shown in Figure 2 if the written code is correct.

4.4. Learning Process

The PHP web programming self-learning system, which utilizes Test-Driven Development (TDD), is made to facilitate the development of both theoretical knowledge and practical coding skills in students by offering an organized and captivating learning environment. The learning process as shown in Figure 3 includes:

1. *Selecting a Learning Topic*: Students choose a topic focused on key PHP web programming areas like variables, control structures, functions, or databases, with objectives and practical coding assignments to apply their knowledge;
2. *Accessing Learning Materials*: Students use tutorials, video lectures, code snippets, and documentation to guide them through the topic objectives, building their understanding incrementally;
3. *Using a Real Coding Environment*: Students code in Visual Studio Code, utilizing features like syntax highlighting and extensions, to gain hands-on experience with professional tools;
4. *Testing Code for Accuracy*: After coding, students run tests to ensure their code meets expected behaviors, using principles of TDD to verify functionality;
5. *Receiving Immediate Feedback*: The system provides instant feedback on test results, helping students learn from errors and understand mistakes in real-time;
6. *Debugging and Refining Code*: Students refine their code based on feedback, engaging in problem-solving to deepen their understanding and coding skills;
7. *Progressing to the Next Task*: Upon successful test completion, students advance to the next objective, building on their knowledge and enhancing their expertise in PHP web programming.

4.5. Structure of Learning Materials

This learning topic is organized based on the Test-Driven Development (TDD) approach, where test files are prepared in advance for each assignment within the project before students begin their work. These tests are designed to assist students in completing their tasks more accurately, as each trial will highlight any mistakes made during the coding process. Therefore, the following elements outline the structure of the learning topics provided:

1. A module that contains material about the project and guidelines for completing the project;
2. Test files that contain code in PHP to verify whether the implemented program code is correct;
3. Support files (supplement files) necessary for the project, such as helper classes.

4.6. Automatic Assistance

The feedback displayed in Figure 3 assists students in identifying, understanding, and addressing defects in their code, resulting in improved code quality, functional accuracy, and more reliable code for software development[30], [31]. The output presented in the terminal displays two types of information: the test status, which indicates whether the test passed or failed and includes error messages if the test fails as feedback, and code improvement information, which shows how many times students have made enhancements or corrections to their code.

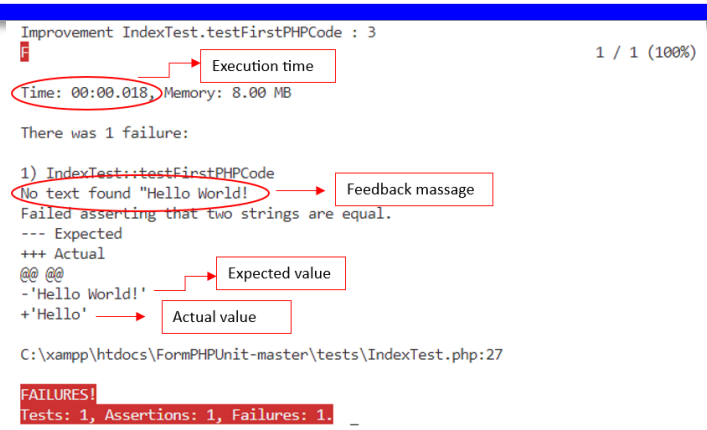

Fig. 3. Automated testing feedback on student

4.7. Implementation of Web Form Learning Topic

This section outlines the implementation stages of the web form learning topic, which includes learning outcomes, practical case studies, and learning assignments.

4.8. Learning Outcomes

This research highlights the importance of PHP web form learning as a foundation for students in creating websites that can handle user data validation and processing securely and efficiently. By providing a self-learning system for web development using form elements in PHP, students are expected to become competent web developers capable of creating responsive and secure websites. By the end of this learning topic, students are expected to achieve the learning outcomes as outlined in the table 2.

Table 1. Six learning outcomes

No	*Learning topic*
LO1	Students can prepare the environment and create a new PHP project.
LO2	Students can apply the use of POST form handling.
LO3	Students can apply the use of GET form handling.
LO4	Students can apply the use of isset() form validation.
LO5	Students can apply the use of \texttt{empty()} form validation.
LO6	Students can apply the use of custom form validation using regular expression.

4.9. Applications for Case Studies

In this practical case study, students will create a simple form page that includes input fields for name, address, email, and a submit button Figure 4 This will illustrate one of the website design layouts that students will work on. On the form page, students are required to implement form validation isset(),empty(), and custom form validation using regular expressions to validate input in the email format.

Students will also study and apply POST and GET form handling as part of this practical case study. They will learn the usefulness of advanced form validation to ensure that the data entered by users in the form adheres to the desired format and is safe for further processing. This case study not only teaches how to create forms but also how to ensure that user input is valid and secure for subsequent operations.

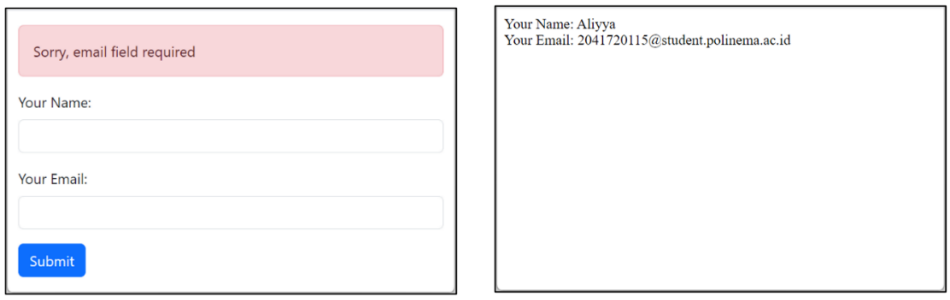

Fig. 4. Automated testing feedback on student

4.10. Learning Tasks

To achieve the learning objectives, a systematic step-by-step approach is essential. Four learning stages have been designed to provide a straightforward learning experience for students, starting from the installation of the necessary software to completing the project as outlined in the practical case study, as detailed in the Tabel 3.

Table 2. Learning task stages

No	*Modules*	*Description*	*Learning Outcomes*
S1	Project Installation and Setup	Set up a development environment and create a PHP project using composer.	LO1
S2	Form Handling	Implementation of POST and GET form handling in the form-testing project.	LO2, LO3
S3	Form Validation	Implementation of form validation isset() in the form-testing project.	LO4
S4	Advanced Form Validation	Implementation of form validation in the form-testing project using empty() and regular expressions.	LO5, LO6

4.11. Code Test

Automated testing of form handling for data submission methods (POST and GET) is conducted using the assertEqualsIgnoringCase function[30],[31]. This function is utilized to compare the values of the method attribute on the form elements, ensuring that they align with the expected methods.

1. *Testing Form Handling with the POST Method*: Testing *of* the form that uses the POST method is conducted by verifying that the method attribute on the form has the value "POST." This test is implemented by writing the following code:

```
$this->assertEqualsIgnoringCase('POST', $form
->attributes->getNamedItem('method')
->nodeValue)
```

Fig. 5. Testing form handling with POST method

With this code, a test is conducted to ensure that the form uses the "POST" method. Function *assertEqualsIgnoringCase()* is a testing method used to compare two strings, where differences in uppercase or lowercase usage (case-insensitive) are not considered an error. In the above code, this method is used to verify that the *method* attribute on the form element has the value "POST" without considering case differences. The function compares the obtained value of the *method* attribute with the expected value, which is "POST." If both values are the same (ignoring case), the test will be deemed successful;

2. *Testing Form Handling with the GET Method*: Similar to the POST method testing, testing of the form that uses the GET method is conducted by ensuring that the method attribute on the form has the value "GET." Below is the code used for this verification:

```
$this->assertEqualsIgnoringCase('GET', $form
->attributes->getNamedItem('method')
->nodeValue, 'The value of the method attribute on the form should be "GET"');
```

Fig. 6. Testing form handling with GET method

With this code, the test ensures that the form uses the "GET" method. The *assertEqualsIgnoringCase()* function compares the strings without considering case differences. This method is used to verify that the *method* attribute has the value "GET." If both values are the same, the test is deemed successful.

3. *Form Validation Testing*: The implementation of automated testing for form validation is carried out by checking the results, values, or conditions returned after the form is submitted. For instance, to validate that the name field must be filled, the check is performed as shown in listing 8 below.

```
ob_start();
include './apps/formRequired.php';

$output = ob_get_clean();
$dom = new DOMDocument();
$dom->loadHTML($output);
$errorMessage = $dom->getElementsByTagName('div')
->item(0)->textContent;
$expectedMessage = "Sorry, name field required";
$this->assertStringContainsString
($expectedMessage, $errorMessage, 'The error message for the condition
$_GET["error"] == "empty_name" is out of specification');
```

Fig. 7. Form validation testing

The testing flow outlined above is as follows:

1. **Buffering Output:** ob_start() starting the capture of the HTML output from the submitted form;
2. **Loading Script:** include './apps/formRequired.php'; executing the form script and capturing its output in the buffer;
3. **Retrieving Output:** ob_get_clean() stores the output from the buffer into the variable $output and clears the buffer;
4. **Parsing HTML:** DOMDocument loads the HTML output to check specific elements.
5. **Retrieving Error Message:** The code searches for text within the ' ' element that contains the error message;
6. **Verifying Message:** 'assertStringContainsString()' checks whether the generated error message matches the expected message. If it does, the test is successful.

Thus, the test ensures that the error message complies with the specifications when the name field is left unfilled.

4.12. Evaluation

This section reinforces the research by implementing the PHP Form topic, which includes automatic correction features in the automated testing feedback, aimed at enhancing the self-learning experience for students.

4.13. Scope of Evaluation

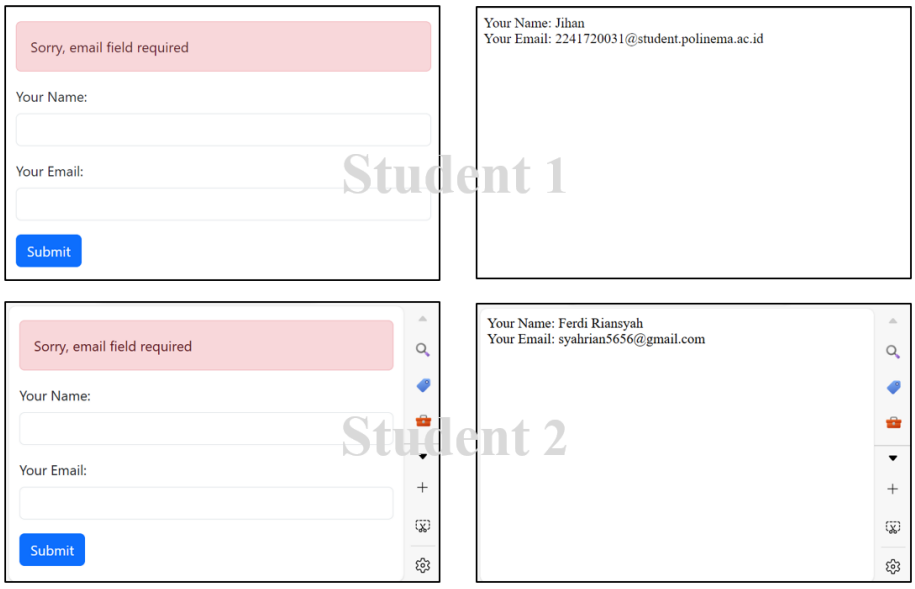

Fig. 8. Sample student application

The evaluation of web learning on the PHP Form topic was conducted with 33 students from Levels 2, 3, and 4 of the D4 Informatics Engineering Program at Politeknik Negeri Malang, who already possessed basic skills in web development. The testing took place over two hours, during which students completed four modules provided via Google Drive. Students then began working according to the instructions and conducted self-testing to ensure that their projects aligned with the provided guidelines. Prior to this, students were asked to record the time taken to complete the assignments and fill out a Google Form to collect comprehensive feedback.

4.14. Student Application Results

During the evaluation process, students were asked to submit their learning project. This was done to review the results of the websites they created. Figure 6 displays the website interface developed by the students, which aligns with the expected design. This similarity is attributed to the presence of PHPUnit test code, which checks HTML code attributes to meet specific values.

4.15. Completion of Assignments by Students

Out of the 33 students participating in the learning evaluation process, 29 successfully completed the assignments in all provided modules, resulting in a pass rate of 87.9% of the total participants.

1. *Completion Time:* Tabel 4 This shows the results of the trial conducted with 33 students, indicating that the majority were able to effectively implement the material taught. The time taken to complete each module varied significantly, with the fastest completion occurring in Module 1 (S1) at 2 minutes, and the longest time recorded in Module 4 (S4) at 48 minutes. However, the average time to complete the four modules was relatively uniform, ranging from 10 to 16 minutes, with the highest average time in Module 4 (S4) at 15.7 minutes. This suggests that each module had a comparable level of difficulty.

Table 3. PHP Forms topic learning evaluation results

Result	*S1*	*S2*	*S3*	*S4*
Passed (students)	33	33	33	29
Fastest (minutes)	2	5	5	5
Average (minutes)	10,2	10,6	10,8	15,7
Longest (minutes)	30	20	24	48

2. *Analysis of Completion Results*: Analysis of the evaluation results for the web form topic indicates that the average time for completing Module 1 (S1) was relatively short, as this stage focused solely on software installation and project initiation, which most students had already completed. The longest time recorded for this stage was 30 minutes for those who followed the installation instructions. In contrast, Module 4 (S4) took considerably longer to complete due to the number of steps involved and the volume of source code lines, which required students to spend more time typing out the code.

On the other hand, four students were unable to complete the entire assignment due to errors that they could not resolve, particularly in Module 4 (S4). In this case, the students' foundational programming knowledge played a crucial role in assisting them with the debugging process for error codes.

4.16. Classification of Topic Difficulty Levels

Table 4. Learning stages classification

Level	*Learning Stages*
Easy	S1
Medium	S2
Hard	S3, S4

The evaluation process conducted with 33 students resulted in 29 students successfully completing the series of tasks from stage 1 to stage 4. Additionally, there were slight differences in the time taken to complete each stage. Based on this analysis, the learning modules for the web form topic can be classified as shown in the table 5

4.17. Learning Feedback

In addition to the time data for completing each module, feedback was also collected from students, revealing positive responses, challenges encountered, and some constructive suggestions. Examples of positive feedback include:

1. The modules are easy to follow;
2. The practical flow is clear and easy to understand;
3. The material is comprehensive and clear;
4. The error messages provided are clear;
5. The presence of error messages as feedback for code testing makes it easier to address errors.

The challenges experienced by students while using the modules include:

1. *Some files in the resources are inaccessible;*
2. *Not all code can be copied;*
3. *There are errors in the code writing.*

Constructive suggestions gathered from student feedback include:

1. *Add an explanation for step 8 when running the composer unit process;*
2. *Add examples of more complex code;*
3. *It might be better to create the unit test files directly within each folder instead of separating them, as this would make it easier to operate. Thank you for your good work.*

4.18. Discussions

The implementation of the self-learning system for PHP web forms underscores the effectiveness of independent study methodologies in equipping students with essential web development skills. By offering a structured learning pathway that progresses from basic environment setup to advanced validation techniques, the program ensures that learners can incrementally build their competencies. This journey enables students to apply theoretical knowledge in practical scenarios, enhancing their ability to create responsive and secure web applications. The self-directed approach empowers students to manage their learning pace, encouraging them to engage deeply with the material and solve assignments that reflect real-world programming challenges.

Central to the system's success is the integration of an automated testing feature, which provides instant feedback on students' code submissions. This feature plays a critical role in the learning process as it allows students to promptly detect and understand errors, facilitating immediate corrective measures without the need for continuous instructor intervention. The clear feedback mechanism formats not only help students learn from their mistakes but also boost their confidence in tackling increasingly complex tasks independently. The high completion rate, with 87.9% of participants successfully finishing all modules, indicates the effectiveness of this approach, though challenges such as dealing with inaccessible resources and ensuring error-free code were noted as areas for improvement.

Looking towards future challenges, the self-learning system must continue to evolve to maintain its relevance and effectiveness. One potential area of development is the enhancement of resource accessibility, ensuring that all learning materials are readily available and error-free. Additionally, incorporating more varied and complex case studies could further stretch students' capabilities and prepare them for diverse scenarios in the web development landscape. Another challenge is to deepen collaboration, perhaps by integrating peer learning opportunities that mirror team-based work environments. Finally, continuously refining the feedback system to cover more nuanced programming errors and solutions will be crucial in supporting students' learning journeys and keeping pace with technological advancements in web development.

5. Conclusion

This paper highlighted the successful implementation of a self-learning system for PHP web form development, emphasizing its educational effectiveness. Key components include clear learning

outcomes, hands-on case studies, and structured learning tasks, all grounded in Test-Driven Development principles. An evaluation with 33 Informatics Engineering students showcased a high completion rate of 87.9%, with students engaging effectively with the modules. The majority completed assignments successfully, with varying times indicating differing complexities across modules. Despite some accessibility issues and debugging challenges, the feedback was largely positive, praising the comprehensive and clear materials and error feedback provided. Constructive suggestions were also gathered to enhance learning experiences further. Overall, the study demonstrates the system's capability to equip students with essential skills in responsive and secure web development using PHP.

Future work could focus on integrating adaptive learning technologies to tailor content to each student's needs and developing collaborative learning features to simulate real-world web development teamwork. Additionally, expanding error handling support and ensuring mobile compatibility would enhance accessibility and effectiveness, while comprehensive assessment tools could better evaluate students' application skills.

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