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Designing an E-Learning Application with Diagnostic Learning Style Testing for Enhancing Personalization in Educational Technology Courses

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ABSTRACT

Teaching the importance of personalized learning in educational technology courses encourages students to understand how tailored educational approaches can enhance learning outcomes. Diagnostic learning style testing, including visual, auditory, kinesthetic (VAK), social, and technology usage dimensions, has been widely recognized as an effective method for addressing diverse student needs. The purpose of this paper is to design an e-learning application with diagnostic learning style testing to enhance personalization in educational technology courses. This system evaluates learning styles based on five dimensions: visual (learning through images and spatial understanding), auditory (learning through listening and verbal communication), kinesthetic (learning through hands-on experiences and movement), social (learning through group interactions and collaboration), and technology usage (learning through digital tools and platforms). The diagnostic results are used to recommend personalized learning strategies tailored to individual preferences. The application is implemented as a web-based platform, providing both theoretical insights and practical applications. By utilizing this system, educators and learners can gain actionable insights into individual learning preferences, ensuring better alignment between teaching methods and student needs. Additionally, the e-learning application can be accessed via mobile devices, allowing for flexible and adaptive learning experiences anytime and anywhere.

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1. INTRODUCTION

Designing personalized learning experiences is a critical task in the context of modern education [1][2]. The ability to tailor learning approaches to individual preferences significantly impacts both teaching effectiveness and student engagement [3][4]. This personalization process involves understanding diverse learning styles, such as visual, auditory, kinesthetic (VAK), and the integration of technology as a key dimension [5][6]. These factors influence how students absorb, process, and retain information, ultimately shaping their academic success. However, identifying and addressing these styles in real-time classroom scenarios often presents challenges for educators [7][8].

Differentiated learning, which involves adapting teaching methods and content to meet the varying needs, abilities, and interests of students, plays a vital role in this personalization process [9]. By recognizing the uniqueness of each learner, differentiated instruction ensures that every student has access to the appropriate level of challenge and support [10][11][12]. This approach enhances student motivation and improves learning outcomes by fostering an environment where all learners can thrive, regardless of their preferred learning styles [13].

E-learning applications serve as powerful tools to address this challenge by integrating diagnostic features for assessing learning styles [14][15][16]. Such systems provide educators with actionable insights and students with customized learning pathways [17][18]. In the field of educational technology, these diagnostic tools enhance the learning process by fostering adaptability and inclusivity, aligning teaching methods with individual needs [19][20]. The incorporation of technology into learning personalization has been widely explored across domains, including technical education, where competencies and outcomes are often product-oriented [21][22].

Diagnostic learning style testing is a systematic approach to identifying student preferences, allowing the application to recommend personalized strategies that match their learning needs [23][24]. Based on the diagnostic test results, learners receive content and materials tailored specifically to their preferred learning styles [25][26]. This approach is particularly relevant in educational technology courses, where students must engage with both theoretical concepts and practical applications [27][28]. By leveraging diagnostic data, e-learning platforms can bridge the gap between diverse learning preferences and standardized teaching methods, ensuring a balanced and effective learning experience [29][30].

This paper discusses the design and development of an e-learning application that integrates diagnostic learning style testing to enhance personalization in educational technology courses. The proposed system not only evaluates learning preferences but also offers actionable recommendations, providing a comprehensive framework for adaptive

learning. The platform is implemented as a web-based application, accessible via mobile devices, ensuring flexibility and scalability in various educational settings.

2. RESEARCH METHOD

The development of the e-learning application starts with identifying students' learning styles through a diagnostic test, categorizing them as visual, auditory, or kinesthetic learners. The test results help customize learning content to individual needs. The system uses criteria like Visual Learning (VL), Auditory Learning (AL), Kinesthetic Learning (KL), Combination of Learning Styles (CLS), and Technology Use (TU) to personalize content. These criteria, based on diagnostic scores, create personalized learning pathways, enhancing engagement and retention.

In the development of this e-learning application, the method used is **Waterfall** [31][30][32]. The Waterfall method was chosen for its simplicity, allowing gradual development in a clear sequence [33][34][35]. It starts with needs analysis to define key features, such as diagnostic learning style testing, aimed at improving personalization in educational technology courses. This is followed by system design, where the interface and structure are created based on user needs. Next, the application is developed with coding and diagnostic feature creation. After development, the app undergoes testing to ensure proper functionality and adherence to specifications. Finally, maintenance ensures the app remains relevant and functions optimally as user needs evolve. The Waterfall approach enables structured and efficient development, focusing on each stage.

2.1. Analysis Proposed System

The proposed e-learning system is designed to meet the needs of personalized learning based on students' learning styles, providing effective, efficient, and adaptive solutions. A system needs analysis includes the identification of business processes, procedures, rules, actors, documents, requirements analysis, specifications of tools, services, and key features required in system development.

2.1.1. Business Process

The business process of the proposed e-learning application is structured to optimize personalized learning by integrating diagnostic assessments with adaptive content recommendations.

Table 1. Business Process

No.	Business Process	Description
1	Identify Learning Styles	Diagnostic tests to identify students' learning styles (visual, auditory, kinesthetic, VAK combinations, and technology use).
2	Content Personalization	Tailor learning materials based on individual learning style test results.

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3	Evaluation and Feedback	Provide learning style-based assessments and feedback to support improved learning outcomes.

As outlined in Table 1, the system workflow begins with students completing a five-dimensional learning style diagnostic test, followed by automated analysis to determine their preferred learning approach. Based on the results, the application generates customized learning pathways, ensuring alignment between instructional content and student preferences. This structured process enhances user engagement and learning outcomes by providing targeted educational experiences.

2.1.2. Operational Business Process

The operational business process of the e-learning application ensures seamless integration between diagnostic learning style assessments and personalized content delivery.

Table 2. Proses Bisnis Operasional

No.	Operational Procedure	Description
1	Learning Style Test	Students complete a diagnostic test designed to identify their learning preferences.
2	Material Personalization	The system automatically provides materials tailored to the results of the learning style test.
3	Learning Process	Students follow the learning process that matches their identified learning preferences.

As illustrated in Table 2, the process begins with user registration and authentication, followed by the administration of a five-dimensional learning style diagnostic test. The system then processes the results to generate individualized learning recommendations, which are dynamically adjusted based on user progress and feedback. This structured workflow enhances the adaptability and effectiveness of the learning experience, ensuring that students receive content tailored to their unique preferences and needs.

2.1.3. Business Rules

Table 3. Business Rules

No.	Business Rule	Description
1	Learning Style Determination	Diagnostic test results determine the student's primary learning style.
2	Adaptive Learning	Learning materials are arranged to meet the needs of individual learning styles.
3	Progress Evaluation	Student learning progress is measured based on interactions with materials and learning style-based evaluation

As outlined in Table 3, these rules govern the matching process between diagnostic learning style results and recommended learning strategies. The system automatically assigns learning materials based on predefined criteria, such as user preferences, performance history, and engagement patterns. These business rules ensure consistency, adaptability, and effectiveness in delivering customized educational experiences, enhancing both student learning outcomes and instructional efficiency.

2.1.4. Actors in the System

Table 4. Actors in the System

No.	Actor	Description
1	Student	Main user who takes tests, receives materials, and performs evaluations.
2	Lecturer	Manager of learning materials and provider of feedback to students.
3	Admin	System manager ensuring smooth operation of the application.

As shown in Table 4, the primary actors include students, instructors, and administrators. Students interact with the platform to complete diagnostic assessments and access personalized learning materials. Instructors monitor student progress, adjust learning strategies, and provide additional guidance based on system recommendations. Administrators manage user accounts, oversee system performance, and ensure smooth operation. These roles are essential in maintaining an effective and adaptive learning environment, facilitating a seamless interaction between users and the platform.

2.1.5. Related Documents

Table 5. Related Documents

No.	Document	Description
1	Learning Style Test Form	Collects data on students' learning style preferences.
2	Learning Preferences	Records the results of students' learning style tests.
3	Quiz Results	Assessments from tests or assignments completed by students.
4	Progress Report	Summary of students' learning progress in the form of graphs or tables.

As outlined in Table 5, these documents include the Learning Style Test Form, which collects data on students' learning style preferences, and the Learning Preferences document, which records the diagnostic results. Additionally, Quiz Results store assessment data from student tests and assignments, while the Progress Report provides a summarized overview of students' learning development through graphical or tabular representations. These documents play a crucial role in ensuring data-driven decision-making, enabling instructors to tailor instructional strategies based on students' individual needs.

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2.1.6. System Requirements Analysis

Table 6. System Requirements Analysis

No.	Type of Requirements	Description
1	Functional Requirements	The system must be able to identify learning styles, provide personalized materials, and provide progress reports.
2	Non-Functional Requirements	Application responsiveness across devices, data security, and system scalability.

As detailed in Table 6, the functional requirements include the system's ability to identify learning styles, deliver personalized learning materials, and generate progress reports. Meanwhile, the non-functional requirements focus on ensuring application responsiveness across devices, maintaining data security, and supporting system scalability. These requirements are essential for providing a seamless, secure, and adaptive learning experience that meets the diverse needs of users.

2.1.7. Specification of Tools and Technology

Table 7. Spesifikasi Alat dan Teknologi

No.	Specifications	Description
1	Platform	Web-based system.
2	Backend	PHP 8.3.8 with Laravel 11.16.0, an alternative to Django (Python) or Node.js (JavaScript).
3	Frontend	Use React.js or Vue.js for a dynamic user interface.
4	Database	MySQL or PostgreSQL for data management.

As outlined in Table 7, the platform is developed as a web-based system. The backend utilizes PHP 8.3.8 with Laravel 11.16.0, providing an alternative to Django (Python) or Node.js (JavaScript) for backend development. For the frontend, React.js or Vue.js is used to create a dynamic and interactive user interface. The system employs MySQL or PostgreSQL as the database management system to efficiently store and process user data. These technological specifications are chosen to enhance system scalability, responsiveness, and security, ensuring a seamless learning experience for users.

2.1.8. Services Provided

Table 8. Services Provided

No.	Service	Description
1	Content Personalization	Learning materials that suit the student's individual learning style.
2	Interactive Feedback	Provide automated feedback based on student evaluation.
3	Mentoring Session	Additional study guides for students with special needs.

As presented in Table 8, the key services include Content Personalization, which tailors learning materials to match students' individual learning styles. Additionally, the Interactive Feedback feature provides automated feedback based on student evaluations, helping them track progress and improve performance. The application also includes a Mentoring Session service, offering additional study guides and support for students with special learning needs. These services are designed to create a more engaging, adaptive, and student-centered learning environment.

2.1.9. Key Features

Table 9. Fitur Utama

No.	Feature	Description
1	Learning Style Test	Diagnostic module to determine the student's learning style.
2	Dynamic Recommendations	Suggestions for learning materials based on the results of learning style tests.
3	Customization Dashboard	User panel to manage study preferences, view progress, and access materials.

As detailed in Table 9, the Learning Style Test serves as a diagnostic module that identifies students' preferred learning styles. Based on the test results, the Dynamic Recommendations feature provides personalized suggestions for learning materials, ensuring content aligns with individual preferences. Additionally, the Customization Dashboard allows users to manage their study preferences, track learning progress, and access recommended materials. These features collectively create a more adaptive and student-centered learning experience, improving engagement and learning outcomes.

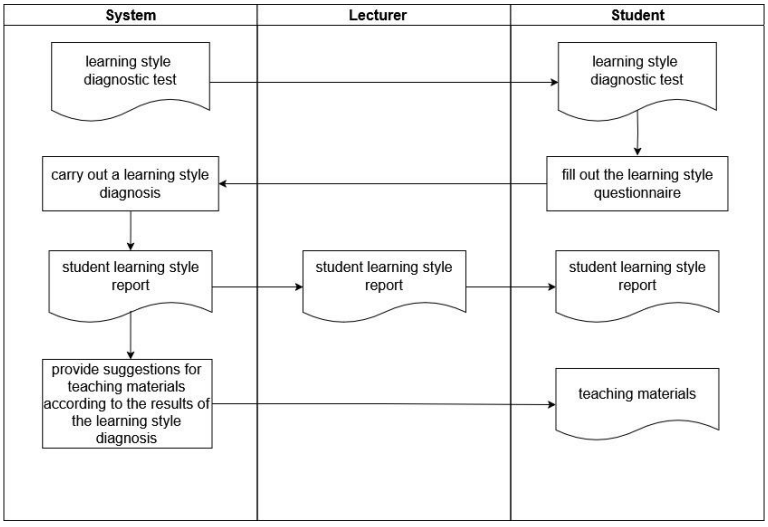


Figure 1. Flowmap Proposed System

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Base on Figure 1 presents the flowmap of the proposed system, which outlines the step-by-step design and development process for the e-learning application. This flowmap serves as a visual representation of the stages involved, from needs analysis and system design to application development, testing, and maintenance, highlighting the structured approach taken to ensure the effectiveness and personalization of the application.

3. RESULTS AND DISCUSSION

The outcomes of the e-learning application, designed with diagnostic learning style testing, are implemented in a web-based platform tailored for educational technology courses. This platform, which adapts content based on individual learning styles, helps students engage with materials that match their preferences. The design of the system integrates diagnostic tools that assess learning styles, enabling the delivery of personalized content to enhance the learning experience. This approach is visualized in Figure 2, which displays the learning style diagnostic test page for admins, illustrating how this feature supports the identification of student needs and assists lecturers in customizing learning content.

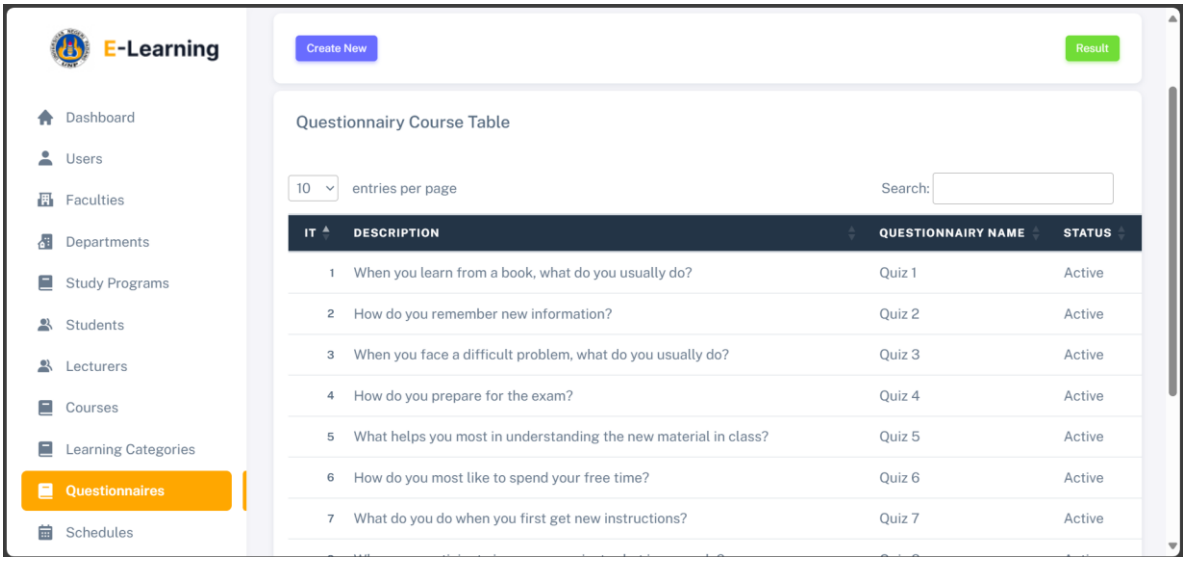


Figure 2. Learning Style Diagnostic Test Page for Admin

Base on Figure 2 is a page for admins to support the management of student learning style diagnostic tests, helping them recognize their learning styles to optimize learning. Admins play an important role in managing questionnaires and test result data, starting from entering questionnaire questions for each learning style to viewing the results of student questionnaire answers. Sedangkan pada mahasiswa hanya diberi akses untuk melakukan test diagnostic gaya belajar melalui kusisioner dapat dilihat pada Figure 3.

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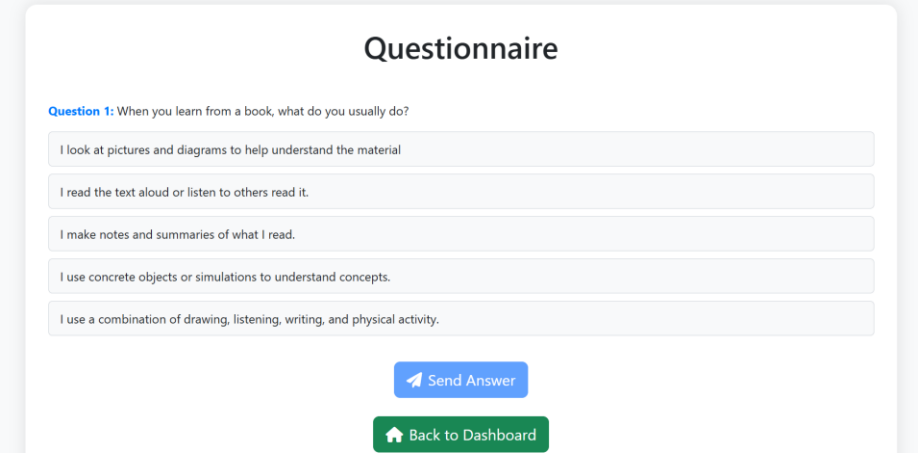


Figure 3. Student Learning Style Diagnostic Test Page

Base on Figure 3 shows the student's learning style diagnostic test page, which is designed to identify their learning preferences, such as visual, auditory, or kinesthetic. This page provides an intuitive interface with structured questions, allowing students to answer easily. The results of this test will be used to personalize the learning experience according to the needs of each student.

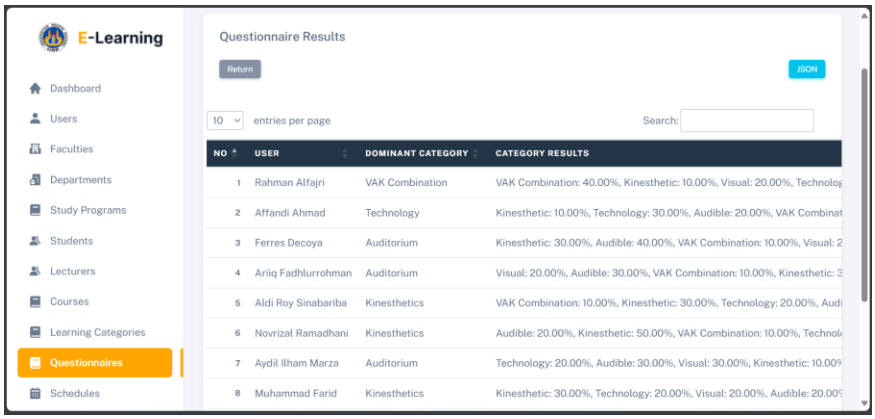


Figure 4. Student Learning Style Diagnostic Test Results Page

Base on Figure 4 shows the results page of the student learning style diagnostic test, which presents an analysis of individual learning styles based on the test results. This page

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provides a clear overview of students' learning preferences, which can be used to adjust teaching materials or materials to make them more effective.

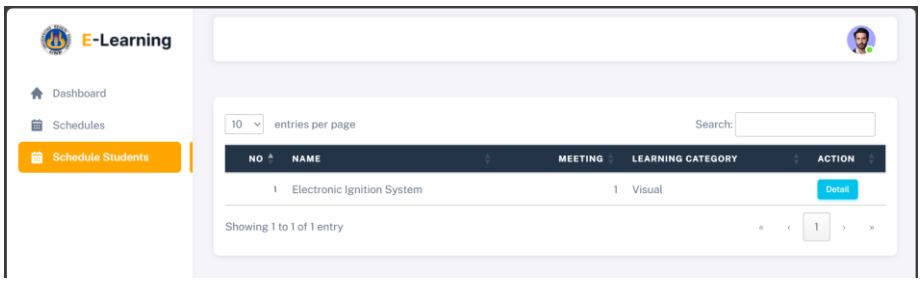


Figure 5. Student Course Page

Base on Figure 5 shows a student course page designed to provide a personalized learning experience. On this page, students can access learning materials tailored to their learning style, follow relevant activities, and monitor their learning progress in real-time. This display is intuitively designed to support active student engagement in the learning process.

Diagnostic learning style testing in ototronic technology courses has been widely recognized as an effective and efficient method for addressing diverse student learning needs [32]. The integration of diagnostic tools in educational technology encourages students to understand how personalized learning strategies can be effectively implemented [36]. This concept is further developed by leveraging **learning style diagnosis**, a widely used educational technology method [28], to enhance personalization, within e-learning environments.

Usability testing was conducted to evaluate the ease of use, efficiency, and user satisfaction of the developed e-learning application. The System Usability Scale (SUS) method was applied, involving 30 respondents, consisting of 20 students and 10 lecturers who actively used the system in the context of educational technology courses. Each respondent completed the SUS questionnaire, which comprises 10 statements, using a Likert scale (1 = strongly disagree, 5 = strongly agree).

The test results, summarized in Table 1, indicate that the application achieved an average SUS score of 78.5, which falls within the "Good" to "Excellent" category based on SUS interpretation standards. Most respondents found the application easy to use (score 4.2), well-organized (score 4.3), and felt confident while using it (score 4.1). However, some difficulties were noted regarding the initial understanding of the system, as indicated by the score of 2.0 on the statement about the need for prior learning before using the application.

Table 10. Average Responses from SUS Questionnaire

No	Statement	Average Score
1	I find this system easy to use	4.2
2	I feel that the system features meet my needs	4
3	I need technical support to understand this system	2.1

4	I find the system features well-organized	4.3
5	I notice many inconsistencies in the system	1.9
6	I feel confident using this system	4.1
7	I have to learn a lot before I can use this system	2
	Average SUS Score	**78.5**

Basen on Table 10 In addition to quantitative data, qualitative feedback from respondents indicated that the personalized learning and interactive dashboard features significantly enhanced the learning experience. However, some users suggested improvements in interface navigation to facilitate easier access to specific features.

Overall, the results confirm that the application meets good usability standards and is ready for implementation in educational settings. However, some refinements, particularly in user experience (UX) and accessibility, should be considered to optimize the effectiveness of personalized learning support.

In personalized e-learning applications, identifying accurate criteria for diagnosing learning styles is crucial [37]. For instance, research on learning styles employs various criteria such as visual, auditory, kinesthetic preferences, cognitive abilities, personality traits, and learning goals [25]. Other studies on diagnostic tools for learning style identification [34] emphasize the importance of using reliable instruments to categorize students based on their preferences effectively [23].

In another study identifying learning styles accurately involves using criteria like engagement patterns, information retention methods, and problem-solving approaches. Based on these criteria, five main dimensions were adopted for this e-learning application: visual, auditory, kinesthetic styles, cognitive processing, and adaptability to learning content. These criteria were selected based on the assumption that they provide a comprehensive understanding of individual learner characteristics and ensure accurate personalization.

Processing data from these diagnostic criteria in the e-learning system generates insights that are subsequently integrated into a computer-based application, designed to improve educational experiences effectively [29]. This approach not only facilitates accurate learning style diagnosis [5] but also results in a product that supports adaptive learning pathways, aligning with the objectives of educational technology courses [38]. Moreover, this e-learning application has potential commercial value, meeting the demands for innovative, student-centered learning solutions in 21st-century education [15].

4. CONCLUSION

The rapid advancements in communication technology and the demand for personalized learning highlight the need for innovative educational approaches. E-learning applications that integrate diagnostic learning style testing offer a solution by tailoring content to individual student preferences. This approach enhances student engagement and

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improves learning outcomes, particularly in educational technology courses. Additionally, the system makes it easier for instructors to deliver personalized learning materials, aligning content with students' learning styles. By bridging the gap between diverse learning preferences and traditional teaching methods, this technology creates more effective and adaptable learning environments.

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