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Design of a Web-Based Tutoring Information System for Dinasbel

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Abstract

This study presents the design and development of a web-based tutoring information system for Dinasbel Education Service Office in Medan, Indonesia. The existing manual registration and data management processes at the tutoring center have resulted in operational inefficiencies, including data redundancy, recording errors, and limited accessibility for stakeholders. To address these challenges, this research employs the Waterfall Software Development Life Cycle (SDLC) methodology, encompassing requirements analysis, system design, implementation, and testing phases. The system architecture incorporates Data Flow Diagrams (DFD) for process modeling and Entity-Relationship Diagrams (ERD) for database design. The proposed system facilitates online student registration, automated attendance tracking, digital payment processing, schedule management, and comprehensive reporting functionalities. System validation through Black Box testing demonstrates successful implementation across all functional modules, including user authentication, data management for registrants, students, subjects, and programs, as well as report generation. The findings indicate that the web-based information system significantly enhances operational efficiency, reduces human error, and improves data accessibility for students, teachers, administrators, and institutional owners. This research contributes to the growing body of knowledge on educational technology implementation in developing countries and provides a practical framework for digitizing tutoring center operations.

Keywords: *Information System Design; Web-Based Application; Tutoring Management; Waterfall Methodology; Educational Technology*

Introduction

The rapid advancement of information technology has fundamentally transformed educational service delivery across the globe (Al-Fraihat et al., 2020). In Indonesia, the education sector has increasingly recognized the necessity of integrating digital systems to enhance administrative efficiency and improve service quality (Purwanto et al., 2020). Tutoring centers, as supplementary educational institutions, play a crucial role in supporting students' academic development by providing additional learning assistance outside formal school settings (Rachmawati & Siregar, 2019). However, many of these institutions continue to rely on traditional manual processes for managing student data, schedules, and financial transactions, resulting in operational inefficiencies and data management challenges.

Dinasbel Education Service Office in Medan represents a typical case of a tutoring center facing these challenges. The institution currently employs paper-based registration forms, manual record-keeping systems, and non-integrated data storage methods. This approach has led to several operational problems, including delayed processing times, susceptibility to recording errors, data duplication, and difficulties in generating timely reports for decision-making purposes (Widyastuti, 2019). Furthermore, the lack of a centralized digital platform limits stakeholder accessibility, preventing students and parents from conveniently accessing schedules, payment information, and academic progress reports.

The implementation of web-based information systems in educational institutions has demonstrated significant benefits in terms of operational efficiency, data accuracy, and stakeholder satisfaction (Laudon & Laudon, 2020). Such systems enable real-time data processing, automated workflow management, and improved communication channels between all parties involved in the educational process. Previous studies have shown

that well-designed information systems can reduce administrative workload by up to 40% while simultaneously improving service delivery quality (Nainggolan, 2023).

This research aims to design and develop a comprehensive web-based tutoring information system for Dinasbel Education Service Office that addresses the identified operational challenges. The study employs the Waterfall SDLC methodology to ensure systematic development and thorough documentation of the system requirements, design specifications, and implementation processes. The specific objectives of this research are: (1) to analyze the existing system and identify areas requiring improvement; (2) to design a web-based information system that facilitates student registration, attendance tracking, payment processing, and reporting; and (3) to validate the system functionality through comprehensive testing procedures.

Literature review

Information Systems in Education

An information system is defined as an integrated collection of components that collect, process, store, and disseminate information to support decision-making, coordination, and control within an organization (Laudon & Laudon, 2020). According to O'Brien and Marakas (2018), information systems comprise five fundamental components: people, hardware, software, data, and networks. These components work synergistically to transform raw data into meaningful information that facilitates organizational operations and strategic planning.

In the educational context, information systems serve multiple functions, including student information management, academic scheduling, financial administration, and performance reporting (Nainggolan, 2023). Web-based educational information systems offer additional advantages such as platform independence, remote accessibility, and real-time data synchronization (Pressman & Maxim, 2020). These systems enable educational institutions to streamline administrative processes, improve data accuracy, and enhance communication between stakeholders.

Tutoring Services and Academic Support

Tutoring services constitute a form of educational intervention designed to assist students in overcoming learning difficulties and achieving academic success (Rachmawati & Siregar, 2019). These services address various student needs, including content comprehension challenges, study skill development, time management strategies, and examination preparation. Research indicates that structured tutoring programs significantly improve student academic performance, particularly when combined with effective monitoring and feedback mechanisms (Mardapi, 2020).

The management of tutoring services requires systematic approaches to student registration, class scheduling, tutor assignment, progress monitoring, and performance evaluation. Traditional manual methods often prove inadequate for handling the complexity and volume of data generated by these processes, necessitating the adoption of computerized information systems (Widyastuti, 2019).

System Development Methodology

The Waterfall model represents a sequential software development approach characterized by distinct, non-overlapping phases: requirements analysis, system design, implementation, testing, deployment, and maintenance (Sommerville, 2016). This methodology is particularly suitable for projects with well-defined requirements and stable specifications, providing clear milestones and comprehensive documentation throughout the development process (Pressman & Maxim, 2020).

Data Flow Diagrams

Data Flow Diagrams (DFD) serve as graphical modeling tools that depict the flow of data through an information system (Nainggolan, 2024). DFDs illustrate system processes, data stores, external entities, and the data flows connecting these elements. Context diagrams (DFD Level 0) provide a high-level system overview, showing the system as a single process interacting with external entities. Lower-level DFDs progressively

decompose processes into greater detail, facilitating comprehensive system understanding and documentation (Dennis et al., 2021).

Entity-Relationship Diagrams

Entity-Relationship Diagrams (ERD) constitute conceptual data modeling tools used to represent the logical structure of databases (Hutapea, 2021). ERDs identify entities (objects about which data is stored), attributes (characteristics of entities), and relationships (associations between entities). This modeling approach facilitates database design by clearly defining data requirements and establishing referential integrity constraints (Connolly & Begg, 2015).

Methods

Research Design

This research adopts a design science research approach, focusing on the creation and evaluation of an IT artifact—specifically, a web-based information system for tutoring management (Hevner et al., 2004). The study employs the Waterfall SDLC methodology, which provides a structured framework for system development through sequential phases.

Data Collection Methods

Primary data were collected through structured interviews with Dinasbel administrative staff, teachers, and management personnel. Direct observation of existing operational processes provided insights into current workflow patterns and pain points. Secondary data were obtained from institutional documents, including registration forms, attendance records, and financial reports. This multi-method approach ensured comprehensive understanding of system requirements and user needs.

System Development Process

The system development followed the Waterfall methodology comprising four main phases: (1) Requirements Analysis—identifying functional and non-functional system requirements through stakeholder consultation and document analysis; (2) System Design—creating system architecture, data models, and user interface specifications using DFD and ERD; (3) Implementation—developing the web-based application using appropriate programming languages and database management systems; and (4) Testing—validating system functionality through Black Box testing procedures.

System Testing Methodology

Black Box testing was employed to validate system functionality without examining internal code structure (Pressman & Maxim, 2020). This testing approach focuses on verifying that system inputs produce expected outputs according to specified requirements. Test cases were designed to cover all functional modules, including user authentication, data management operations (create, read, update, delete), and report generation functionalities.

Results and Discussion

Current System Analysis

Analysis of the existing system at Dinasbel revealed a predominantly manual operational workflow involving four primary stakeholder groups: prospective students, administrators, teachers, and institutional owners. The current process flowchart illustrates the sequential activities performed by each stakeholder category.

Prospective students must physically visit the registration office to complete paper-based registration forms and submit direct payments. Administrators manually compile subject lists, program schedules, student data, class assignments, and tutoring schedules. They also receive registration forms, issue payment receipts, and maintain

handwritten activity and financial reports. Teachers access manually prepared schedules and conduct tutoring sessions according to predetermined timetables. Institutional owners review paper-based reports to monitor operational performance.

This manual approach presents several significant limitations: (1) time-consuming registration processes requiring physical presence; (2) susceptibility to data entry errors and inconsistencies; (3) difficulty in data retrieval and report generation; (4) limited scalability as student enrollment increases; and (5) lack of real-time information access for stakeholders.

Proposed System Design

The proposed web-based information system addresses identified limitations through digital transformation of key operational processes. The system architecture supports four user roles with differentiated access privileges: students, teachers, administrators, and owners. Proposed system flowchart depicting streamlined digital workflows.

Context Diagram (DFD Level 0)

The context diagram illustrates the system's interactions with four external entities. Students interact with the system through registration, login, attendance submission, and payment data entry, receiving schedule information, grades, class details, program information, and attendance records in return. Teachers provide login credentials, subject data, program details, schedules, lesson hours, and grades, while accessing student information, room assignments, and class rosters. Administrators manage comprehensive system data, including login credentials, subjects, programs, teacher records, student information, verification processes, rooms, and classes. Owners access the system for login, receive administrative data and student verification information, and monitor attendance records.

Data Flow Diagram Level 1

The DFD Level 1 decomposes the system into constituent processes, showing detailed data flows between processes and data stores. The diagram identifies key processes including user authentication, registration management, attendance tracking, payment processing, schedule management, and report generation. Data stores encompass student records, teacher records, subject databases, program information, attendance logs, and payment transactions.

System Implementation

The web-based information system was implemented with a multi-role authentication mechanism supporting four distinct user categories. Displays the login interface, which requires valid email and password credentials for system access. The authentication module enforces role-based access control, ensuring users can only access functionalities appropriate to their designated roles.

The dashboard interface serves as the primary navigation hub, providing users with access to key features and services based on their role permissions. The dashboard displays summarized information, navigation menus for accessing various system modules, announcements, and quick search functionality. This centralized interface design enhances user experience by minimizing navigation complexity and providing immediate access to frequently used features.

System Testing Results

Black Box testing was conducted to validate system functionality across all modules. Table 1 presents the testing results, demonstrating successful implementation of all tested functionalities.

Table 1. Black Box Testing Results

Test Class	Test Scenario	Expected Result	Status
User Login	Click Login button	System displays main menu after successful authentication	Passed
Registrant Data	Add Data	New registrant data saved to database upon clicking save	Passed
	Update Data	Modified data saved to database upon clicking update	Passed
	Delete Data	Selected data removed from database upon clicking delete	Passed
Student Data	Add Data	New student data saved to database upon clicking save	Passed
	Update Data	Modified data saved to database upon clicking update	Passed
	Delete Data	Selected data removed from database upon clicking delete	Passed
Subject Data	Add Data	New subject data saved to database upon clicking save	Passed
	Update Data	Modified data saved to database upon clicking update	Passed
	Delete Data	Selected data removed from database upon clicking delete	Passed
Program Data	Add Data	New program data saved to database upon clicking save	Passed
	Update Data	Modified data saved to database upon clicking update	Passed
	Delete Data	Selected data removed from database upon clicking delete	Passed
Reports	Click Reports	System displays all generated reports	Passed

The testing results indicate that all functional modules operate according to specifications. The login functionality successfully authenticates users and directs them to appropriate interfaces based on their roles. Data management modules for registrants, students, subjects, and programs correctly execute create, update, and delete operations with proper database synchronization. The reporting module generates comprehensive reports as designed.

Discussion

The successful implementation of the web-based tutoring information system demonstrates the applicability of systematic development methodologies in addressing operational challenges faced by educational institutions. The Waterfall approach proved effective for this project given the well-defined requirements and stable specifications identified during the analysis phase.

The proposed system offers several advantages over the existing manual processes. First, online registration eliminates the requirement for physical presence, enabling prospective students to enroll conveniently from any location with internet connectivity. This feature is particularly beneficial in expanding service accessibility and reducing administrative bottlenecks during peak registration periods. Second, automated data processing significantly reduces human error risks associated with manual data entry and calculations. The database-driven architecture ensures data consistency, integrity, and efficient retrieval. Third, the real-time reporting functionality enables institutional owners and administrators to monitor operations and make informed decisions promptly.

These findings align with previous research on educational information system implementation. Widyastuti (2019) similarly reported efficiency improvements following web-based system adoption in tutoring centers. The current study extends this body of knowledge by providing a comprehensive design framework specifically tailored to the operational context of Indonesian tutoring institutions, incorporating local requirements for multi-stakeholder access and bilingual content support.

However, certain limitations warrant acknowledgment. The current implementation does not include integrated payment gateway functionality, requiring manual payment verification processes. Additionally, the system is designed exclusively for web browsers, potentially limiting accessibility for users preferring mobile applications. Future development should address these limitations to enhance system utility and user convenience.

Conclusion

This research successfully designed and developed a web-based tutoring information system for Dinasbel Education Service Office in Medan. The system addresses operational inefficiencies inherent in manual processes by providing digital solutions for student registration, attendance tracking, data management, and reporting. Key conclusions derived from this study include:

First, the Registration Information System enables convenient online enrollment, eliminating the necessity for physical presence and thereby improving accessibility and efficiency.

Second, the digital payment processing mechanism enhances transaction efficiency and provides clear documentation of financial records.

Third, automated data processing substantially reduces human error risks through systematic input validation and database-driven storage mechanisms.

Recommendations for Future Development

Based on the findings and limitations identified, the following recommendations are proposed for future system enhancement:

First, integration with payment gateway services (such as Midtrans, Xendit, or similar platforms) would facilitate automated transaction processing and support diverse payment methods including bank transfers, e-wallets, and credit cards.

Second, development of companion mobile applications for Android and iOS platforms would enhance accessibility and convenience for all stakeholder groups.

Third, implementation of video recording and playback features would enable asynchronous learning, allowing students unable to attend live sessions to access recorded materials.

Fourth, incorporation of learning analytics dashboards would provide insights into student progress and enable data-driven instructional improvements.

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