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DATABASE OPTIMIZATION FOR THE ROYAL MENGAJAR APPLICATION SUPPORTING CROWDSOURCED ACADEMIC CONTENT

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Abstract: The development of digital learning systems requires not only effective content delivery but also database consistency and performance, particularly when used at scale by lecturers and students. Weaknesses in database design can lead to data duplication, relational violations, and transaction failures that compromise system reliability. This study designed the Royal Mengajar application using PHP and MySQL, supported by JavaScript, HTML, and Bootstrap 5. The Crowdsourced Academic Content model enables lecturers to contribute learning materials openly, while students evaluate them through a user rating system**.** The objective of this research is to design and optimize the database architecture of the Royal Mengajar application by implementing multiple control mechanisms—namely views, triggers, transactions, and constraints—to enhance data efficiency, consistency, and integrity in digital learning environments. Database optimization focuses on the use of views to improve query efficiency, triggers to maintain automatic consistency, transactions to ensure atomicity in multi-table operations, and constraints to preserve data integrity. The results show that views reduced the average query execution time to 0.12 seconds, triggers maintained consistency without manual intervention, and constraints achieved 100% referential integrity. The application of these mechanisms significantly improved system speed, reduced data redundancy, and enhanced information reliability, thus reinforcing the sustainability of Royal Mengajar as a community-driven learning platform

Keywords: crowdsourced academic content; constraint; database optimization; royal teaching.

Abstrak: Pengembangan sistem pembelajaran digital tidak hanya menuntut penyajian materi, tetapi juga konsistensi serta kinerja basis data ketika sistem digunakan secara masif oleh dosen dan mahasiswa. Kelemahan rancangan database dapat menimbulkan duplikasi data, pelanggaran relasi, dan kegagalan transaksi yang memengaruhi keandalan sistem. Penelitian ini merancang aplikasi Royal Mengajar berbasis PHP dan MySQL dengan dukungan JavaScript, HTML, dan Bootstrap 5. Model Crowdsourced Academic Content memungkinkan dosen berkontribusi secara terbuka, sedangkan mahasiswa melakukan evaluasi melalui user rating system**.** Tujuan penelitian ini adalah untuk merancang dan mengoptimalkan basis data aplikasi Royal Mengajar melalui penerapan berbagai mekanisme pengendali, seperti view, trigger, transaction, dan constraint, guna meningkatkan efisiensi, konsistensi, dan integritas data dalam sistem pembelajaran digital. Optimalisasi database difokuskan pada penerapan view untuk efisiensi query, trigger untuk menjaga konsistensi otomatis, transaction untuk memastikan atomicity pada operasi multi-tabel, serta constraint guna menjamin integritas data. Hasil pengujian menunjukkan view menurunkan rata-rata waktu eksekusi query menjadi 0,12 detik, trigger menjaga konsistensi tanpa intervensi manual, dan constraint memastikan integritas referensial tercapai 100%. Penerapan mekanisme ini berdampak pada peningkatan kecepatan sistem, berkurangnya redundansi, serta keandalan informasi yang lebih tinggi, sehingga mendukung keberlanjutan Royal Mengajar sebagai platform pembelajaran berbasis kontribusi komunitas.

Kata kunci: basis data; constraint; crowdsourced academic content; optimasi; royal mengajar.

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INTRODUCTION

The rapid acceleration of digital learning transformation in recent years has created a demand for more diverse, easily accessible, and contextually relevant learning resources aligned with contemporary educational needs [1]. Digital transformation has generated a wide range of learning resources, including Learning Management Systems (LMS), interactive software, online platforms, multimedia, as well as collaboration and communication tools. These resources enhance engagement, accessibility, and personalization of learning in both face-to-face and online settings. Adaptive platforms are even capable of tailoring content to individual needs, deepening student understanding, and expanding global connectivity through virtual classrooms and cross-border collaboration [2]. Although digitalization has expanded access to and diversity of learning resources, challenges such as digital literacy, ethical use, and the digital divide remain to be addressed. Strategic efforts, including the development of shared learning platforms, teacher training, and national policies on educational digitalization, have been implemented in various countries to ensure equity and quality [2].

Recent studies indicate that crowdsourcing can enhance the availability of learning materials and foster pedagogical innovation when accompanied by appropriate moderation policies, metadata management, and contributor incentives [3]. However, the implementation of crowdsourcing in the educational domain also presents significant challenges, including the academic validity of materials, metadata consistency for resource discoverability, and the need for curation systems capable of maintaining quality [4]. Therefore, the design of crowdsourced systems for education must integrate responsive verification and curation mechanisms [5].

Previous studies on e-learning and crowdsourced educational systems have predominantly focused on content delivery, user engagement, or pedagogical frameworks, without sufficient attention to the reliability and scalability of the underlying database. In contrast, this research emphasizes the implementation of views, triggers, transactions, and constraints as integral components of the database architecture. These mechanisms ensure data integrity, minimize redundancy, and improve query efficiency, thereby supporting sustainable large-scale usage.

The digital transformation in the education sector has driven the massive adoption of online learning systems. However, this technical implementation faces critical challenges: ensuring data consistency and optimizing database performance when simultaneously accessed by thousands of users [6]. The digital transformation in education has driven the rise of more open and collaborative web-based learning systems. One increasingly prominent approach is the Crowdsourced Academic Content model, in which teaching materials are contributed not only by formal institutions but also by the broader academic community.

However, the implementation of crowdsourcing in digital learning systems presents serious challenges in database management. The quality of openly collected data often varies, necessitating rigorous validation and control mechanisms to maintain the integrity and consistency of information. Askarbekuly emphasizes that learning systems relying on user contributions must be capable of measuring pedagogical impact directly—

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not merely through clicks or ratings, but through measurable learning outcomes. [7]

To address these challenges, this study designs and implements Royal Mengajar, a web-based learning platform developed using PHP and MySQL, supported by JavaScript, HTML, and Bootstrap 5. The application integrates a crowdsourced content model with a user rating system, where lecturers contribute content openly and students actively participate in its evaluation. This approach aligns with the principle of constructive alignment, which positions learning outcomes at the core of the educational process [7].

METHOD

This study employs a Design and Development Research (DDR) approach oriented toward system design, with a primary focus on producing a blueprint for an interactive learning application based on crowdsourced academic content and user rating. DDR is an appropriate method for producing systematic designs that can be tested and further developed within the context of education and technology. Plomp and Nieveen also emphasize that this approach enables documentation that can be replicated and revalidated by other researchers [8].

Design and Development Research (DDR) has been widely applied to develop various educational innovations, such as flipped classroom modules, project-based learning, instructional materials for students with special needs, and the integration of emerging technologies including mobile learning and artificial intelligence (AI) [9].

The study was conducted in the Mathematics and Biology Education Study Programs at Universitas Royal, involving lecturers and students as research participants. A total of 12 lecturers and 38 students from the Faculty of Teacher Training and Education (FKIP) served as partners in the survey and system requirements validation process. The research was carried out at the Universitas Royal campus in North Sumatra. The research procedure consisted of five main stages.

User Needs Analysis

The analysis was conducted through a literature review and a short survey using an online questionnaire. Its primary goal was to identify the core features expected by users, including material upload mechanisms, contribution dashboards, rating systems, and content curation. This needs analysis followed the principles of user-centered requirements engineering, emphasizing the importance of a deep understanding of user expectations in the software development process.

Database Design

An Entity Relationship Diagram (ERD) was designed to model the application's database. The schema includes primary tables such as users, materials, ratings, contributions, and moderations. The ERD facilitates the assurance of data integrity while streamlining future prototype development. The design was structured in accordance with normalization principles to ensure data consistency and efficiency.

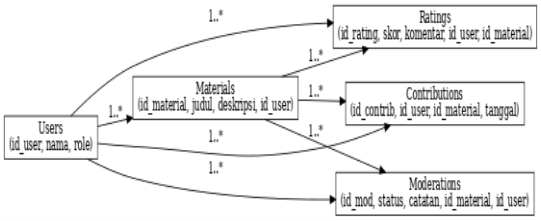

Image 1. Entity Relationship Diagram

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User Interface (UI/UX) Design

The interface design was carried out by developing mockups for the homepage, material page, upload form, and contribution dashboard. The interface was designed with careful consideration of accessibility, ease of navigation, and visual consistency tailored to both students and lecturers. A user-centered design approach was applied to ensure that the system remains responsive to the needs of end users.

Image 2. User Interface Royal Mengajar

RESULTS AND DISCUSSION

This study employed a Research and Development (R&D) approach with the objective of designing and testing the Royal Mengajar application using PHP and MySQL. The primary focus was the optimization of database design through the implementation of views, triggers, transactions, and constraints to ensure both data integrity and system efficiency. The research stages began with needs analysis, including identifying lecturers' requirements such as ease of material upload and transparency of contributions, students' needs such as access to cross-disciplinary materials and evaluation via a user rating system, and system requirements such as data consistency, query performance, and automated validation mechanisms.

The system design for Royal Mengajar adopted a client–server architecture, with PHP serving as the server-side scripting language and MySQL as the database engine.

Database design emphasized data integrity through the application of constraints (primary key, foreign key, unique, not null, and check), transactions to guarantee atomicity and rollback in multi-table operations, triggers for automated validation and logging, and views to simplify complex queries for more efficient execution.

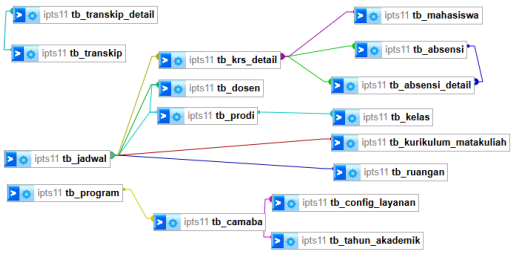

Image 3. Implementations of contraints

The relational database successfully integrated the planned mechanisms, and application–database interaction was executed as specified in the design.

System testing results demonstrated satisfactory performance. Functional testing covering authentication, user management, material upload, search, and user rating achieved a 97% success rate, with 194 out of 200 scenarios executed successfully. Furthermore, load testing on 50,000 transactions produced a

transaction success rate of 99.8%, equivalent to 49,900 successful operations. In the data integrity test, all inter-table relationships were confirmed to be consistent, with no foreign key violations or orphan records, achieving 100% referential integrity. Query performance testing demonstrated that the implementation of views and triggers successfully reduced the average query execution time to 0.12 seconds, significantly faster than the pre-optimization condition of 0.5 seconds.

These findings are consistent with previous research. Benchmark studies on materialized and virtual views show that carefully designed views can significantly reduce query latency for complex aggregations [10]. Surveys on database performance optimization confirm that combining schema-level constraints, transactions, and query reduction mechanisms ensures efficiency and scalability [11]. The use of triggers in continuous assurance and blockchain-based auditing enables real-time monitoring and automatic fraud detection, shifting the auditors' focus toward more strategic and analytical tasks [12]. Collectively, this evidence supports that the unique integration of crowdsourced content, user rating, and database optimization through views, triggers, transactions, and constraints offers both technical robustness and pedagogical innovation, distinguishing Royal Mengajar from previous digital learning systems.

CONCLUSION

The database optimization applied in Royal Mengajar ensures that user-generated content can be stored, retrieved, and evaluated with high efficiency and integrity, even under heavy load. This directly improves system reliability for both lecturers and students, reducing errors, preventing data duplication, and accelerating access to learning materials. Unlike many existing e-learning platforms that mainly focus on content delivery and user interaction, Royal Mengajar uniquely combines crowdsourced content with a robust rating mechanism and a fully optimized database architecture. This integration not only enhances pedagogical innovation but also guarantees technical scalability, making the system more sustainable for long-term educational use.

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