

Inovasi Farmakoinformatika: Kalkulator Berbasis Web untuk Meningkatkan Praktik dan Pendidikan Farmasi

Pharmacoinformatics Innovation: A Web-Based Calculator to Enhance Pharmaceutical Practice and Education

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Abstrak

Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi kalkulator farmasi berbasis web yang dirancang untuk meningkatkan pendidikan dan praktik profesional farmasi dengan menyediakan perhitungan farmakologis yang akurat dan efisien. Tujuannya adalah untuk menciptakan alat yang dapat disesuaikan, ramah pengguna, dan akses terbuka yang membantu mahasiswa dan profesional farmasi dalam melakukan perhitungan farmakologis yang kompleks, yang pada akhirnya meningkatkan hasil pembelajaran dan mengurangi kesalahan pengobatan dalam praktik klinis. Dengan menggunakan metodologi Penelitian Berbasis Desain (DBR), penelitian ini melibatkan tiga fase: penggalan kebutuhan, pengembangan sistem menggunakan alat low-code, dan penilaian kegunaan. Aplikasi ini dikembangkan menggunakan CMS WordPress dengan plugin Elementor untuk memastikan fungsionalitas dan desain antarmuka yang berpusat pada pengguna. Sebuah studi kegunaan, menggunakan Skala Kegunaan Sistem (SUS), dilakukan, dengan umpan balik yang dikumpulkan dari mahasiswa dan praktisi farmasi. Hasilnya menunjukkan penerimaan dan kepuasan pengguna yang tinggi, dengan sebagian besar responden menganggap kalkulator ini mudah digunakan dan efektif baik dalam pembelajaran akademis maupun tugas klinis. Alat ini secara signifikan mengurangi kesalahan manusia, meningkatkan pemahaman konsep farmakologis, dan menyederhanakan perhitungan dosis yang kompleks. Kesimpulannya, kalkulator farmasi berbasis web ini berhasil menjembatani kesenjangan antara pengetahuan teoretis dan aplikasi praktis, berkontribusi pada praktik farmasi yang lebih aman dan pendidikan farmakologi yang lebih baik. Alat ini mengurangi beban kognitif dan kesalahan manusia, menawarkan solusi yang terukur untuk kebutuhan pendidikan farmasi dan pengambilan keputusan klinis yang terus berkembang. Pengembangan di masa mendatang dapat mencakup fitur-fitur canggih seperti pemeriksaan interaksi obat dan dukungan multibahasa, yang semakin memperluas potensinya untuk penggunaan global..

Kata Kunci: *Kalkulator Farmasi; Farmakoinformatika; Aplikasi Berbasis Web; Studi Kegunaan; Perhitungan Dosis Obat*

Abstract

This study aimed to develop and evaluate a web-based pharmaceutical calculator designed to enhance pharmaceutical education and professional practice by providing accurate and efficient pharmacological calculations. The objective was to create a customizable, user-friendly, and open-access tool that assists pharmacy students and professionals in performing complex pharmacological computations, ultimately improving learning outcomes and reducing medication errors in clinical practice. Utilizing a Design-Based Research (DBR) methodology, the research involved three phases: requirements elicitation, system development using low-code tools, and usability assessment. The application was developed using WordPress CMS with the Elementor plugin to ensure functionality and a user-centered interface design. A usability study, employing the System Usability Scale (SUS), was conducted, with feedback collected from pharmacy students and practitioners. The results showed high user acceptability and satisfaction, with most respondents finding the calculator easy to use and effective in both academic learning and clinical tasks. The tool significantly reduced human error,

improved understanding of pharmacological concepts, and simplified complex dosage calculations. In conclusion, the web-based pharmaceutical calculator successfully bridges the gap between theoretical knowledge and practical application, contributing to safer pharmaceutical practices and enhanced pharmacological education. The tool reduces cognitive load and human error, offering a scalable solution for the evolving needs of pharmacy education and clinical decision-making. Future developments could include advanced features such as drug interaction checks and multilingual support, further expanding its potential for global use..

Keywords: *Pharmaceutical Calculator; Pharmacoinformatics; Web-Based Application; Usability Study; Drug Dosage Calculation*

BACKGROUND

The advancement of digital technologies has significantly transformed various domains in healthcare, including pharmaceutical sciences. As clinical complexity increases and personalized medicine becomes the norm, the demand for computational tools to support accurate, rapid, and reproducible pharmacological calculations has grown (Damiani, 2020). These tools are particularly valuable in pharmacy practice and education, where precision in drug dosing and regimen design is critical. Pharmacoinformatics, a subfield of biomedical informatics, plays an increasingly pivotal role in bridging data science with pharmaceutical knowledge (Chatterjee, 2016). It integrates information technology, pharmacology, and decision science to enhance the effectiveness and efficiency of pharmaceutical services. One of its primary objectives is to streamline the management, interpretation, and application of drug-related data for clinical and educational purposes (Nilansari & Putri, 2022).

Despite the theoretical integration of pharmacoinformatics in academia and clinical settings, its practical implementation remains limited, particularly in developing regions. Many pharmacy professionals and students still rely on manual calculations or outdated tools, which increases the risk of medication errors and diminishes learning efficiency (Ghani et al., 2010). There is a pressing need to develop modern, accessible, and scalable tools to bridge this gap. Web-based applications have emerged as one of the most practical platforms for disseminating pharmacoinformatics tools due to their accessibility, platform independence, and ease of updates. The development of web-based pharmaceutical calculators allows users to perform complex dosage and pharmacokinetic computations with enhanced accuracy and user-friendliness, thereby reducing cognitive load and error probability (Wang & Durrant, 2022).

Several previous studies have introduced desktop or mobile applications for pharmacological calculations. However, many of these tools are either commercially restricted, lack customization features, or do not align with local clinical guidelines and educational curricula. Therefore, there exists a critical opportunity to develop an open-access, customizable, and educationally relevant web-based calculator tailored to local and global pharmaceutical needs (Montero-Pastor et al., 2023). The current study presents a pharmacoinformatics-driven innovation in the form of a web-based pharmaceutical calculator designed to support both pharmaceutical education and professional practice. This tool was developed with a user-centered approach, incorporating feedback from pharmacists, pharmacy students, and educators to ensure its relevance, accuracy, and usability (Harrap et al., 2016).

Functionally, the application provides modules for drug dosage calculation, body surface area estimation, pediatric dose adjustment, and IV infusion rate computation, among others. These features are embedded within a responsive and secure web interface built on modern development frameworks, ensuring compatibility across devices and operating systems (Higi et al., 2022).

From an educational perspective, the calculator also serves as a pedagogical aid by reinforcing the theoretical principles of pharmacokinetics, dose adjustment, and clinical pharmacology through practical engagement. It not only minimizes human error but also enhances conceptual understanding for students in pharmacy and medical fields (Bereda, 2022). To evaluate the utility and effectiveness of the web-based calculator, a usability study using the System Usability Scale (SUS) was conducted among pharmacy students and practitioners. The study aimed to determine the system's acceptability, efficiency, and potential integration into academic curricula and clinical workflows (McQueen et al., 2010).

In conclusion, this paper discusses the design, development, and evaluation of a web-based pharmaceutical calculator within the framework of pharmacoinformatics. The innovation is anticipated to serve as a foundational tool that bridges theoretical knowledge and practical application, contributing to safer pharmaceutical practices and enhanced pharmacological education in the digital era.

METHODS

1. Research Design

This study utilized a Design-Based Research (DBR) methodology, emphasizing iterative development and real-world validation of a pharmacoinformatics tool. The methodological framework included three main phases: (1) contextual inquiry and requirements elicitation, (2) system development using low-code tools, and (3) usability assessment. This

design ensures alignment between technological development and user-centered educational or clinical needs. Can be seen figure 1.

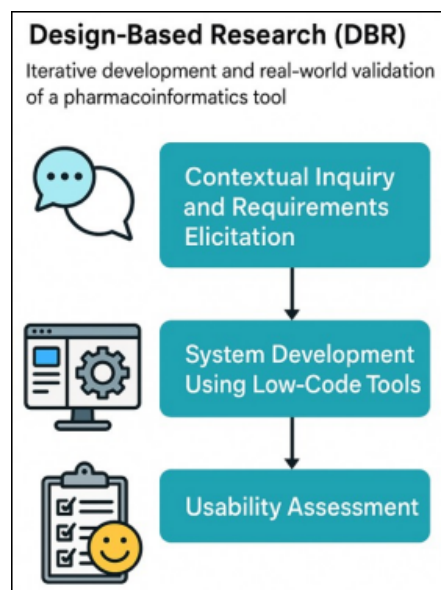


Figure 1. Design-Based Research (DBR)

2. Platform and Development Framework

The application was built using **WordPress CMS**, selected for its adaptability and extensibility. The **Elementor** plugin served as the primary interface builder, enabling rapid front-end design without full-stack coding. Custom **HTML** were embedded via Elementor's code blocks to execute pharmaceutical calculations in real-time. This *low-code development approach* accelerated deployment while maintaining functional depth and clinical relevance.

3. Functional Specification

The web-based calculator comprises multiple modules designed for pharmacological decision support.

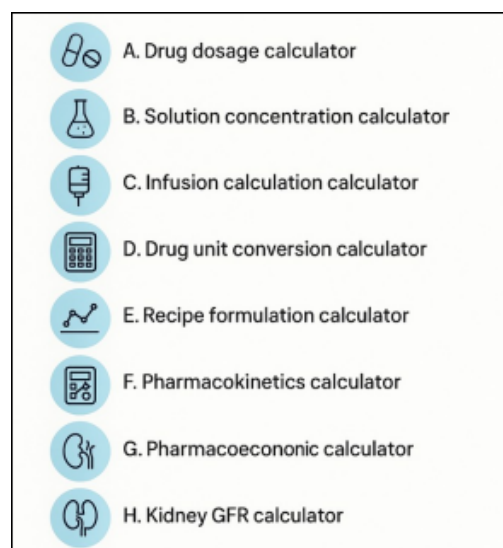


Figure 2. Functional spesification

Each module incorporates validated mathematical logic and operates independently through front- end scripting. Results are displayed instantaneously upon user input, improving workflow efficiency. Can be seen figure 2.

4. Scientific Data Integration and Validation

The **formulas and clinical references** implemented within each calculator module were derived from rigorously validated sources, including:

- Peer-reviewed scientific **journals** indexed in PubMed and Scopus
- **Research articles** on pharmacokinetics, drug dosage adjustment, and renal function estimation
- Reputable **e-textbooks** in pharmacy such as *Applied Therapeutics*, *Clinical Pharmacokinetics*, and *Basic & Clinical Pharmacology*

These references were synthesized into a structured *domain-specific knowledge base* that guided both the logic of calculations and the explanatory content shown to users. Validation was carried out through cross-checking results with textbook examples and clinical case simulations, reviewed by practicing pharmacists.

5. User-Centered Interface Design

Development followed a **user-centered design (UCD)** approach. Informal interviews and structured feedback were collected from 10 licensed pharmacists and 6 senior pharmacy students in Gorontalo, Indonesia. Their feedback informed both the functional prioritization and UI/UX refinement, including mobile responsiveness, label clarity, and input/output behavior.

6. Hosting and Technical Deployment



Figure 3. Functional specification

The tool was deployed on a secure server under the domain <https://apotekgorontalo.com/halaman-pilihan-kalkukator-farmasi/>, with HTTPS encryption. Compatibility and stability were ensured through regular plugin updates and security patches. The design supports all major browsers and devices, optimized for both desktop and mobile access. Can be seen figure 3.

7. Questionnaire

To assess the functionality of this pharmaceutical calculator application, a questionnaire was created and distributed via Google Form. This questionnaire is designed to collect feedback from users regarding various aspects of the interface, ease of use, and the impact of the application in both academic and professional contexts. The questionnaire can be accessed via the following link: <https://s.ung.ac.id/FarmakoInformatikaUNG>.

The questionnaire consists of 10 questions covering several categories: user interface, ease of use, assistance in academic work, and impact on professional tasks. Each question is rated using a Likert scale, where:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

Below is the list of questions included in the questionnaire:

1. The interface of the pharmaceutical calculator is visually appealing and easy to understand.
2. The elements within the calculator, such as buttons and labels, are clear and easy to read.
3. The navigation process in the pharmaceutical calculator is easy and not confusing.
4. I find it easy to input data and obtain calculation results using the calculator.
5. This calculator helps me understand pharmacological concepts taught in my courses.
6. Using this calculator makes it easier for me to perform complex drug dosage calculations during my studies.
7. This calculator makes it easier for me to perform drug dosage calculations while working as a pharmacist.
8. The calculator's features, including body surface area estimation and pediatric dose adjustments, are very helpful in my daily work.
9. Overall, I am satisfied with the use of this pharmaceutical calculator both in academic settings and professional work.
10. I would recommend this pharmaceutical calculator to my colleagues or fellow pharmacy students.

After collecting data through this questionnaire, an analysis was conducted to evaluate the functionality of the application based on the feedback received. The results of this questionnaire provide valuable insights into how effective the application is in supporting users in both academic and professional contexts with total respondent n = 200

RESULTS

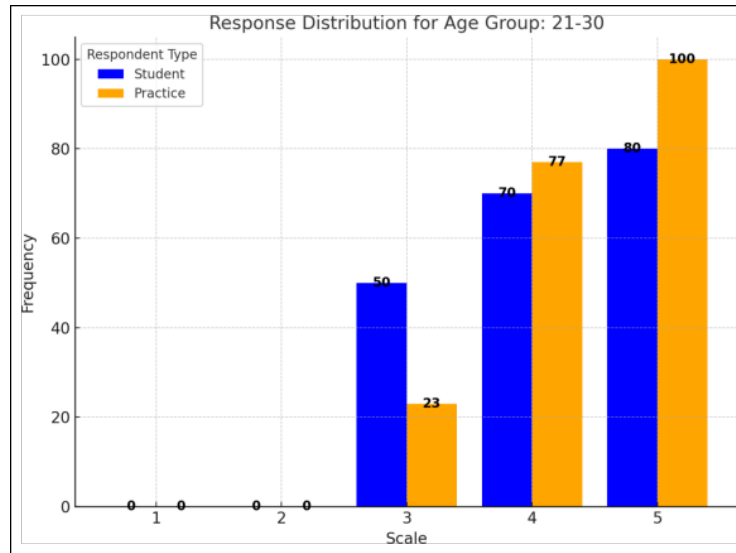


Figure 4. Respondent Distribution for Age Group 21-30

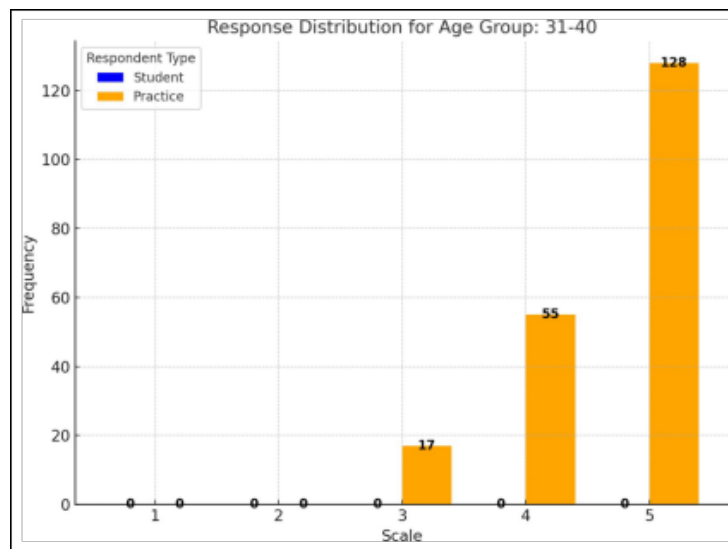


Figure 5. Respondent Distribution for Age Group 31-40

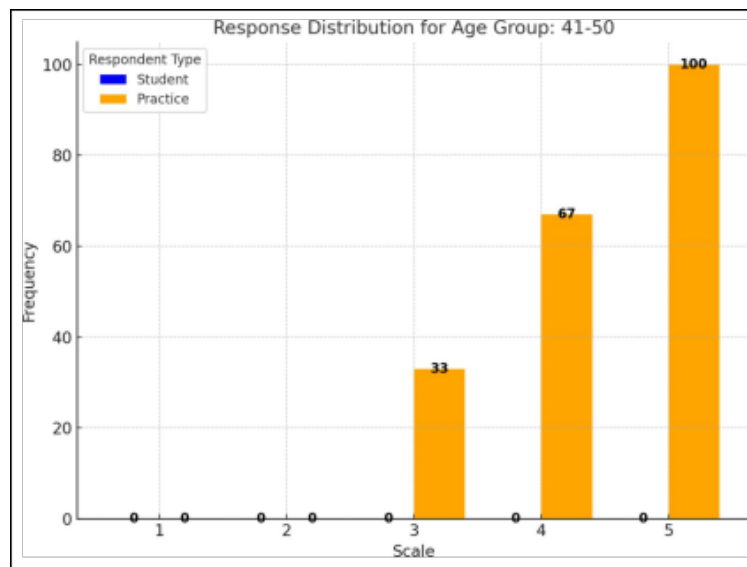


Figure 6. Respondent Distribution for Age Group 41-50

DISCUSSION

The development of the web-based pharmaceutical calculator marks a significant advancement in the integration of digital technology with pharmaceutical education and practice. The tool effectively bridges the gap between theoretical pharmacological knowledge and its practical application, offering support in drug dosing calculations, pharmacokinetics, and educational reinforcement. By enabling quick, accurate calculations, it reduces cognitive load for students and professionals alike, while also minimizing the risk of human error. This is particularly important as clinical practice becomes more complex and personalized medicine continues to expand, highlighting the need for accessible, accurate tools that can support decision-making in real-time.

The usability study conducted with pharmacy students and practicing pharmacists reveals the high acceptability and effectiveness of the tool. In the 21-30 age group, predominantly made up of students, the responses reflected a strong preference for the tool, with 50 students rating it as "Neutral" (Scale 3), 70 rating it "Agree" (Scale 4), and 80 rating it "Strongly Agree" (Scale 5). Practicing pharmacists in this age group also showed significant satisfaction, with 23 rating it as "Neutral," 77 "Agree," and 100 "Strongly Agree." These results highlight the calculator's usability and its potential to enhance both learning outcomes and clinical workflows by providing an efficient, error-reducing solution for routine pharmaceutical calculations.

The response from the 41-50 age group, particularly from practitioners, further emphasizes the value of this tool in clinical practice. Among these pharmacists, 33 rated the tool "Neutral," 67 rated it "Agree," and 100 rated it "Strongly Agree," illustrating its effectiveness in reducing the time required for manual calculations and supporting clinical decision-making. This user group, which deals with more complex patient cases, found the tool essential for performing accurate dosage calculations and adjusting drug regimens. These findings are consistent with the growing need for accessible, time-saving technologies in healthcare settings that help professionals navigate intricate clinical tasks with ease and precision.

From an educational perspective, the calculator serves as a valuable pedagogical aid, particularly for students in pharmacy and medical fields. The tool provides students with a practical, hands-on approach to understanding pharmacological concepts such as pharmacokinetics, dose adjustments, and pediatric care. The ability to perform real-time calculations reinforces theoretical learning, making abstract concepts more tangible and less prone to error. Feedback from the 31-40 age group of practitioners, who rated the tool with 17 "Neutral," 55 "Agree," and 128 "Strongly Agree," indicates that professionals, especially in the early stages of their careers, benefit significantly from the calculator's ability to simplify complex calculations while also enhancing their conceptual understanding of pharmacology.

Looking forward, the tool's scalability and adaptability offer significant potential for future developments. Its web-based platform allows it to be used across various devices, providing flexible access for both students and professionals. Future versions of the tool could integrate additional functionalities such as drug interaction checks, advanced pharmacokinetic modeling, and multilingual support to cater to a more global audience. Furthermore, its integration with electronic health records (EHRs) and other clinical platforms could further enhance its utility in real-world clinical settings. While the current study provides a comprehensive evaluation of the tool's effectiveness, future research should focus on testing its interoperability with existing pharmacy management software and exploring its adoption in different healthcare systems around the world.

CONCLUSION

This study presents the development and evaluation of a web-based pharmaceutical calculator aimed at enhancing both pharmaceutical education and practice. By integrating pharmacoinformatics, the tool supports drug dosage calculations, pharmacokinetics, and clinical decision-making, reducing human error and cognitive load for students and professionals. The usability study demonstrated its high acceptability, with positive feedback from pharmacy students and practitioners. The calculator serves as a valuable educational tool, reinforcing theoretical concepts and improving learning outcomes. Its scalable, adaptable design holds potential for future enhancements, including integration with clinical systems and the addition of advanced features, making it a crucial resource for modern pharmaceutical practice.

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