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Innovation in Post-Stroke Rehabilitation: Developing an Educational Application for Family Caregivers

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Abstract – Stroke is a major cause of mortality and disability worldwide, with a rapidly increasing prevalence in Indonesia. Post-stroke patients often experience motor impairment, functional decline, and high dependency on family caregivers. Limited caregiver knowledge and skills often due to insufficient training, lack of access to reliable rehabilitation information, and minimal involvement in patient education during hospital discharge frequently hinder effective rehabilitation, reducing the quality of home care. This study aims to design and develop an audiovisual-based educational application to improve caregiver's competence in assisting post-stroke rehabilitation. The application integrates structured video tutorials covering range of motion exercises, muscle strengthening, balance and coordination training, and daily transfer and ambulation guidance. The Research and Development (R&D) method was employed, as it enables systematic product development through iterative design, expert validation, and user testing to ensure the educational application is both affective and feasible for practical use. This approach is considered the most appropriate for developing and evaluating innovative educational media compared to purely observational or experimental methods. Expert judgment using the Content Validity Index (CVI) indicated high validity with an S-CVI/Ave score of 0.90, confirming the application's feasibility as an educational medium. With a user-friendly interface and comprehensive multimedia content, the application provides practical knowledge accessible anytime and anywhere. The findings suggest that this innovation effectively supports caregiver education, enhances patient independence, and promotes better rehabilitation outcomes. Overall, the development of this application highlights the potential of digital health solutions in bridging gaps in post-stroke care and improving survivor's quality of life.

Keywords – Caregiver; Educational Application; Rehabilitation; Stroke

I. INTRODUCTION

Stroke is a major global health burden and remains one of the leading causes of mortality and disability worldwide. According to the World Health Organization (WHO), stroke ranks among the top three causes of death and long-term disability, with a prevalence that continues to rise across different regions, including Asia [1]. In Indonesia, the 2018 Basic Health Research (Riskesdas) reported that stroke prevalence increased significantly from 7 per 1,000 population in 2013 to 10.9 per 1,000 population in 2018, indicating a growing number of individuals living with post-stroke complications [2]. The increasing incidence of stroke underscores the urgent need for effective rehabilitation and family-centered care strategies to improve patient's quality of life.

Post-stroke individuals often experience various complications, such as motor impairment, communication disorders, dysphagia, visual disturbances, and psychological issues, including depression, which can hinder rehabilitation outcomes [3][4][5]. Functional limitations make it difficult for patients to perform daily activities independently, leading to long-term dependency on family members or caregivers[6]. Caregivers thus play a crucial role not only in supporting basic needs but also in providing motivation, emotional support, and assistance with rehabilitation exercises [7][8]. Stroke not only impacts the patient but also creates challenges for families, especially caregivers, who play an essential role in supporting rehabilitation and daily activities [9]. However, many caregivers face challenges due to limited knowledge and preparedness, particularly when patients are discharged from hospitals [10]. This knowledge gap can negatively affect the rehabilitation process and patient's overall recovery [11].

In response to these challenges, technological advancements have significantly transformed healthcare delivery. The rise of digital health, telemedicine, and mobile health applications has enabled the integration of education, monitoring, and rehabilitation services into accessible platforms. Digital transformation allows caregivers and patients to overcome barriers of distance, cost, and limited access to healthcare facilities, while also providing continuous support and evidence-based guidance [12]. The advancement of digital health technology provides opportunities to develop innovative learning media in the form of mobile applications. Mobile health (mHealth) applications have been shown to support health promotion, patient monitoring, and caregiver education effectively [13][14]. Several studies confirm that mobile-based education can improve health literacy, treatment adherence, and self-management among both patients and caregivers [15]. Recent studies have shown that telerehabilitation and audiovisual-based interventions can effectively enhance knowledge, promote exercise adherence, and support functional recovery in post-stroke patients [16][17]. The emergence of health applications illustrates how innovation in information technology can directly improve patient outcomes and caregiver competence [18].

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Despite these promising developments, existing studies mainly focus on general stroke management or secondary prevention, with limited attention to caregiver-focused educational applications targeting functional rehabilitation, such as range of motion (ROM), balance, coordination, and transfer activities [19][20]. Therefore, there is a clear research gap in developing tailored digital interventions for stroke caregivers.

To address this gap, the present study aims to design and develop an educational application specifically for caregivers of post-stroke individuals. The application developed for Android devices using Figma for interface design and Android Studio for implementation. It features a structured menu containing audiovisual instructional materials on range of motion (ROM), muscle strengthening, balance and coordination, and transfer or ambulation guidance. Each module includes step by step video demonstrations, text explanations, and interactive reminders to assist caregivers in practicing rehabilitation activities at home. The application also includes a progress tracking feature that allows caregivers to record completed sessions, helping them monitor patient improvement. With its simple and intuitive interface, the app is designed to be easily accessible for users with limited digital experience, promoting better understanding and adherence to rehabilitation routines. The application integrates audiovisual instructional materials on rehabilitation exercises and daily mobility assistance, with the goal of enhancing caregiver's knowledge and skills. By strengthening caregiver education, this innovation is expected to improve the quality of home-based care, promote patient independence, and ultimately optimize post-stroke rehabilitation outcomes.

Therefore, this study adopts the Research and Development (R&D) approach as its methodological framework. The R&D method is designed to develop and validate educational products through a systematic process involving needs analysis, design, expert validation, revision, and testing [21][22]. This approach is appropriate for creating and evaluating innovative educational media such as digital health applications, ensuring that the final product is both effective and feasible for practical use.

II. RESEARCH METHODOLOGY

This study employs the *Research and Development* (R&D) method. R&D is a systematic approach used to design new products, develop specific innovations, or refine and improve the quality of existing products [21][22]. The primary aim of this method is to generate innovations that provide meaningful benefits to society. The R&D process involves several stages, including problem or opportunity identification, design planning, product development, and implementation through evaluation or production [22]. This method emphasizes a structured and well-defined procedure, utilizes creativity and innovation to find solutions, and incorporates feasibility testing to ensure the practicality and effectiveness of the developed product or innovation [23].

The application developed in this study is a mobile health application (m-Health app) designed for Android smartphones. It is categorized as a health education and monitoring tool that provides information and guidance for stroke survivors and their family caregivers in order to prevent recurrent stroke. Participants can access the application through their Android devices after installing the APK file. The file was shared by the research team through a secure link (Google Drive) [24].

The development phase began with designing the application interface using Figma, followed by coding and system integration through Visual Studio Code and Android Studio, while MySQL was used for database management. The educational content consisted of audiovisual materials, including instructional videos on Range of Motion (ROM), balance, coordination, strength training, and daily transfer techniques.

Expert validation was conducted by physiotherapy professionals and media specialists to ensure the feasibility and appropriateness of the application. Revisions were made based on expert feedback, and the product was further tested in a small-scale trial involving caregivers to evaluate usability and user satisfaction. Data from expert reviews and trials were analyzed descriptively to determine the feasibility of the application as an educational tool.

The development of this educational application for post-stroke caregivers was undertaken by researchers in collaboration with Informatics Engineering students at Muhammadiyah University of Surakarta, who contributed to the coding and system design process. The application development followed several systematic stages, including interface design, programming, and integration of educational video content into the system. The implementation period was planned for six months, from September 2024 to February 2025. This application serves as a digital platform that provides structured instructions and audiovisual materials to enhance caregiver's knowledge and skills in post-stroke management. The educational content includes range of motion exercises, muscle strengthening, balance and coordination training, as well as daily transfer and ambulation techniques aimed at supporting optimal recovery and functional independence of stroke survivors.

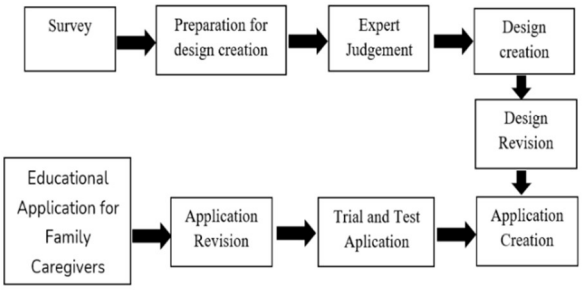

Figure 1. Flow of Application Creation Stages

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The development process of the educational application followed several systematic stages, as illustrated in Figure 1. The process began with a survey stage, which aimed to identify the needs of post-stroke caregivers through literature review and preliminary observation. This stage helped determine the caregiver's knowledge gaps, difficulties in rehabilitation assistance, and preferred learning media. The next stage was preparation for design creation, where the conceptual framework and storyboard of the application were developed based on the survey results. Educational materials were selected from validated physiotherapy resources and organized into an audiovisual format suitable for mobile learning.

The expert judgement stage involved validation by physiotherapy and educational technology experts to assess the accuracy, clarity, and suitability of the content and interface design. Afterward, the design creation stage was carried out using Figma to produce a user-friendly interface, followed by the design revision stage, in which improvements were made according to expert feedback regarding layout, navigation, and instructional flow. The subsequent application creation stage involved coding and system integration using Android Studio, Visual Studio Code, and MySQL to combine visual design, database, and video content into a functional application. Once the prototype was built, the application revision stage focused on debugging and fine tuning to enhance usability and remove technical errors. Finally, the trial and testing stage was conducted with a small group of caregivers to evaluate the app's accessibility, ease of use, and satisfaction level, providing feedback that confirmed its feasibility as an educational tool for post-stroke rehabilitation.

The design stage was carried out to create the application's interface so that users could easily navigate and engage with the educational application features provided. The next stage was coding, which was performed by programming experts, in this stage, the researcher was assisted by Informatics Engineering students to process data using programming languages interpretable by computers. The final stage was data input, in which educational videos were integrated into the system to ensure that they could be accessed and displayed properly when the application is used. Here are some of functions in the application:

Table 1. Feature and Function

Feature	Function
Educational Videos	Provide step-by-step audiovisual guidance for caregivers on post-stroke care.
Transfer and Ambulation Training	Teach caregivers safe techniques to assist patients in daily mobility activities.
Range of Motion (ROM) Exercises	Demonstrate passive and active ROM exercises to prevent stiffness and maintain joint mobility.
Muscle Strengthening Exercises	Provide structured training to improve muscle strength in stroke survivors.
Balance and Coordination Exercises	Offer guided exercises to improve postural control and coordination.
User-Friendly Interface	Ensure that the application is easy to navigate for caregivers with minimal technical skills.

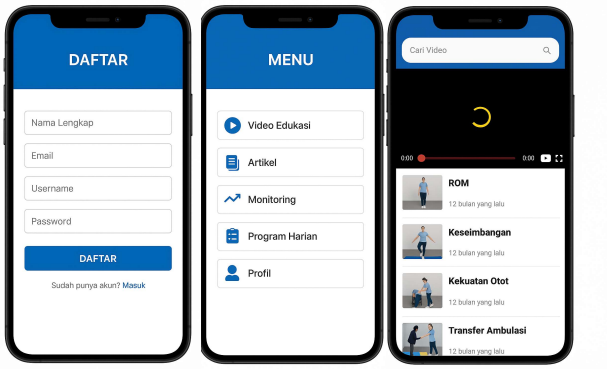

Figure 2. Display of Features Application

Figure 2 shows the display of several main features of the post-stroke caregiver educational application. The first page illustrates the registration form, where users are required to enter personal information such as full name, username, email, and password to create an account. After registration, users are directed to the main menu page, which provides access to several important features. The third display highlights the educational video feature, where caregivers can access audiovisual materials related to physiotherapy for post-stroke individuals. These videos contain practical demonstrations, such as range of motion (ROM) exercises, strengthening, and transfer techniques. The fourth display shows the educational article menu, which provides written materials and structured information about stroke, early detection (FAST screening), rehabilitation programs, and exercise guidelines.

Caregivers begin by registering an account through the registration page. Once logged in, they can navigate the main menu to select the desired feature. For daily learning, caregivers can watch educational videos by selecting the Exercise or Rehabilitation menu. In addition, they can read educational articles for a deeper understanding of stroke management. The *Monitoring* and *Home Program* features allow caregivers to apply the knowledge in daily care routines and keep track of patient progress. Through this structured flow, the application supports caregivers in both theoretical understanding and practical implementation of post-stroke care.

The educational application for post-stroke caregivers was validated through expert judgment using the Content Validity Index (CVI). A total of three validators participated, consisting of 1 media experts (Informatics) and 2 material experts (Physiotherapy). The Content Validity Index (CVI) is widely used to evaluate the relevance, clarity, and appropriateness of items in health-related instruments or applications [23]. By applying CVI, researchers can guarantee that the developed application meets scientific and clinical standards.

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Table 2. Result of CVI

Item	Expert 1	Expert 2	Expert 3	Expert in Agreement	I-CVI	UA
P1	1	1	1	3	1	1
P2	1	1	1	3	1	1
P3	1	1	1	3	1	1
P4	1	1	1	3	1	1
P5	1	1	0	2	0.67	0
P6	1	0	1	2	0.67	0
P7	1	1	1	3	1	1
P8	1	1	1	3	1	1
P9	1	0	1	2	0.67	0
P10	1	1	1	3	1	1
				S-CVI/Ave	0.90	
				S-CVI/UA		0.70

The expert validation of the post-stroke caregiver educational application was analyzed using the Content Validity Index (CVI) method. Based on the assessment of three validators, the results showed an S-CVI/Ave of 0.90, indicating that, on average, the items in the application demonstrated a very high level of content validity. Meanwhile, the S-CVI/UA value was 0.70, which means that 70% of the items were fully agreed upon by all experts, while a few items required minor revisions. These findings confirm that the application's content, both in terms of physiotherapy materials and media display, is aligned with the required standards. Therefore, the application is considered valid and feasible to be used as an educational tool to improve caregiver's knowledge and skills in providing post-stroke care.

III. RESULTS AND DISCUSSION

The development process of the mobile health application involved several tools and platforms. Android Studio was used as the primary Integrated Development Environment (IDE) for building the Android prototype, while Visual Studio Code supported additional coding and interface adjustments. For data management, MySQL was implemented to handle user information and application content stored in the backend database. Figures 3-5 illustrate the working environment of the development tools used in this study.

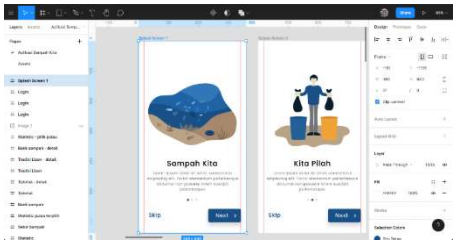

Figure 3. Figma

Figure 3 shows the interface design process using Figma, which was utilized to create user interface layouts and visualize the navigation structure of the mobile application.

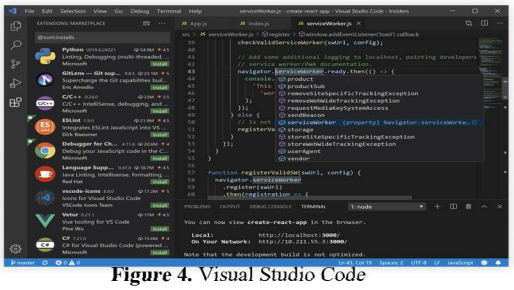

Figure 4. Visual Studio Code

Figure 4 presents the coding and interface adjustment process using Visual Studio Code, which supported the integration of multimedia content and improved system functionality.

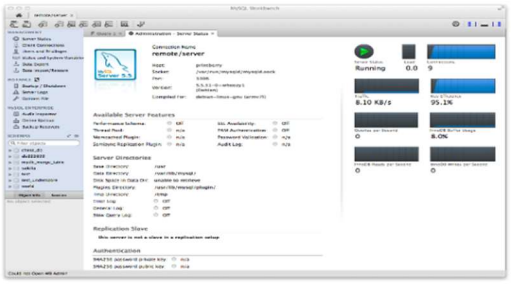

Figure 5. MySQL

Figure 5 illustrates the data management process using MySQL, which was applied to store user information and application content in the backend database.

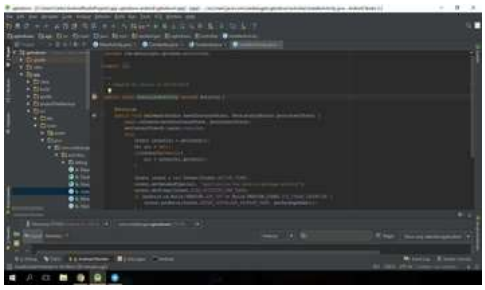

Figure 6. Android Studio

Figure 6 shows the Android Studio environment used as the primary Integrated Development Environment (IDE) for building and testing the mobile application prototype. This platform facilitated interface design, coding, and debugging processes to ensure optimal functionality of the educational application.

The development of an audiovisual-based educational application for post stroke caregivers resulted in a product with structured content on range of motion (ROM), strengthening, balance, coordination, and transfer training. The expert validation using the Content Validity Index (CVI) demonstrated a high level of feasibility, with an S-CVI/Ave of 0.90 and an S-CVI/UA of 0.70. These findings indicate that the application content is relevant, clear, and appropriate for use as an

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educational medium to support caregiver competence in post-stroke care.

To further illustrate the validation outcomes, the detailed results of the expert assessment are presented in Table 1. The table shows the item-wise analysis of material and media aspects evaluated by experts. Most items obtained I-CVI values above 0.80, indicating a strong level of agreement regarding the accuracy of physiotherapy materials and the usability of the interface. These findings confirm that the application is both valid and feasible as an educational medium for family caregivers.

Table 3 Expert Validation Result of the Educational Application

Aspect	Number of Items	I-CVI Range	Mean I-CVI	S-CVI /Ave	S-CVI/ UA	Category
Material (Physiotherapy Content)	5	0.80-1.00	0.92	0.90	0.70	Very Valid
Media (Interface) & Design)	5	0.75-1.00	0.88	0.89	0.68	Valid
Total Average	**10**	-	**0.90**	**0.90**	**0.70**	**Highly Valid & Feasible**

The results in Table 1 align with the quantitative findings of the CVI analysis, reinforcing that the developed audiovisual based educational application meets the required standards of accuracy, clarity, and usability for post-stroke caregiver education.

The high CVI scores suggest that both media and material aspects of the application meet professional standards, ensuring that caregivers can easily access reliable rehabilitation information. This aligns with previous studies reporting that mobile health interventions enhance health literacy and self-efficacy in caregivers [15][20]. Similarly, audiovisual-based education has been shown to improve adherence to rehabilitation exercises and knowledge retention among family caregivers [17].

Compared with earlier mobile health innovations that primarily focused on stroke prevention [19], the present application is specifically tailored to functional rehabilitation at home, filling an important gap in caregiver education. This distinction highlights its novelty and potential impact in empowering families to deliver effective rehabilitation support. The integration of video-based demonstrations is particularly valuable, as visual learning facilitates better comprehension of exercise techniques than text-based resources alone [13]. Moreover, the inclusion of daily transfer and ambulation guidance addresses practical challenges caregivers often face, which are rarely emphasized in existing applications.

From a boarder perspective, the findings of this study support the role of digital health in bridging accessibility barriers for stroke rehabilitation, especially in low-resource settings. By enabling continuous caregiver education, the application may contribute to improved patient independence and reduced caregiver burden. This aligns with the global trend of digital transformation in health services [18].

The results confirm that the developed application is a valid, feasible, and innovative educational tool. Its focus on functional rehabilitation, combined with audiovisual delivery, distinguishes it from previous studies and demonstrates significant potential to enhance post-stroke care at home. Future large-scale trials are warranted to evaluate its effectiveness in improving clinical outcomes and caregiver preparedness.

IV. CONCLUSION

This study developed an educational application for post-stroke caregivers using the Research and Development (R&D) method, consisting of interface design, coding, and integration of educational videos on ROM, strengthening, balance, coordination, and transfer training. The expert judgment results using the Content Validity Index (CVI) showed an **S-**CVI/Ave of 0.90 and an S-CVI/UA of 0.70, indicating that the application is valid and feasible as an educational medium. With its user-friendly interface and comprehensive multimedia features, the application provides caregivers with accessible knowledge and practical guidance to support patient rehabilitation at home. Therefore, this application is considered an innovative tool to enhance caregiver skills, promote patient independence, and improve the quality of life of stroke survivors. For future research, further development could involve expanding the application's content to include more comprehensive rehabilitation modules, integrating real-time feedback features, and testing its effectiveness through larger clinical trials. Additionally, collaboration with healthcare institutions may help to enhance usability and ensure broader accessibility for stroke caregivers.

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