



Responsive Web-Based Learning Platform for Early Detection of Breast Cancer

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Abstract: Cancer continues to be a serious global health concern. Misconceptions, stigma, and cultural beliefs exacerbate the issue of cancer awareness in many communities, leading to late-stage diagnosis when treatment options are scarce. It has been observed that early discovery and availability to trustworthy information are critical to both prevention and control. In this study, a responsive web-based platform that combines web technology and human-centered design is designed and developed with the goal of improving cancer education for the general population. The platform was developed using a modular architecture. The front end of the study design utilizes Next.js, React and TypeScript for the web-based learning platform while the back end is designed using PostgreSQL, deployed via Supabase for persistent and dynamic storage of educational content. REST and GraphQL APIs were also used to implement a seamless integration with the React-based front end. Key system components include an interactive homepage, categorized cancer information modules, and multilingual content delivery to support diverse user demographics. The platform was tested across multiple devices to ensure compatibility and responsiveness, leveraging media queries and flexible grid systems for optimal display. This implementation demonstrates the viability of web-based health education tools, particularly in regions with limited access to structured medical information. It also supports multiple languages through dynamic language selection and database-driven content localization, enhancing accessibility in multilingual communities.

Keywords: User-Centered Design, Dynamic Content Management, Responsive Web Development, Multilingual Support, Web-Based Health Education

INTRODUCTION

Millions of people die from cancer every year, making it one of the biggest public health issues in the world. In 2020 alone, cancer claimed around 10 million lives, according to the World Health Organization (WHO), underscoring the critical need for early identification, preventive education, and prompt medical care [1]. Public awareness is still low in many places despite international efforts to battle cancer, especially in low and middle-income nations where access to trustworthy health information is limited by constraints related to language, digital literacy, and infrastructure [2]. Despite the initiatives made by public health organizations, Public health initiatives are severely hampered not only by restricted access but also by pervasive false information and misconceptions around cancer. Many societies still hold onto common beliefs, such as the idea that cancer is invariably fatal, spreads easily, or is always the result of supernatural forces [3]. These false beliefs have the potential to postpone diagnosis, lower treatment compliance, and deter people from obtaining expert medical assistance. False claims are frequently amplified by social media platforms and unreliable internet sources, making it more challenging for people to discern between reliable medical advice and pseudoscience [4-8]. Trusted, centralized systems that offer various audiences clear, reliable, and evidence-based cancer information are obviously needed.

Digital technologies, especially web-based platforms, offer a powerful means of disseminating health information to wide and diverse audiences. However, many existing platforms are either poorly designed, non-responsive, or lack inclusive features such as multilingual support, limiting their effectiveness among underserved populations. This research

addresses this gap by developing a responsive web application, combined with localized and multilingual content delivery with the following goals;

- To develop a responsive web platform for disseminating cancer-related information.
- To implement multilingual content delivery for inclusive user reach.
- To demonstrate how web technologies can support public health education in resource-constrained settings.

The platform addresses gaps in accessibility, user engagement, and content localization by providing structured, medically accurate, and dynamically managed content. Key features include a user-friendly interface, mobile responsiveness, multilingual support, and categorized educational resources. The remainder of this paper is organized as follows: Section 2 provides reviews of related work and existing systems. Section 3 outlines the methodology and technologies used. Section 4 presents the system implementation as well as results and discussion. Section 5 concludes the paper and proposes directions for future development.

This study adds to knowledge by demonstrating how a responsive, web-based platform may effectively improve cancer education by combining human-centered design with modern web technologies like Next.js, React, TypeScript, and PostgreSQL. It offers a scalable and multilingual framework that increases access to reliable health information, especially in resource-constrained and culturally diverse contexts. The study also demonstrates the technological viability of employing interactive, user-centered applications to raise public health awareness, providing a replicable paradigm for future technology-driven health treatments.

RELATED WORKS

Over the past decade, the rise of digital health has transformed how educational content is delivered to the public. Web-based platforms and mobile applications have emerged as scalable and cost-effective channels for disseminating cancer information. The increasing importance of using e-learning resources to enhance cancer screening and diagnosis around the globe has been highlighted by recent studies. According to studies by [9-11], e-learning platforms can help specialists and health care practitioners become more proficient in cancer prevention and increase their understanding of cancer control and patient care.

Several studies have reported the development of hybrid e-learning applications with embedded multimedia resources to foster the awareness of cancer. The ColorApp project in Malaysia, developed using the Nominal Group Technique (NGT), delivered colorectal cancer education through a hybrid mobile/web application, achieving high usability scores and demonstrating potential for behavior change [12,13].

A web-based platform for West African communities was developed. This platform incorporated local storytelling traditions, proverbs, and survivor video testimonials in native languages. The study employed a mixed-methods approach, combining quantitative quizzes and qualitative interviews, and found that faith-based messaging integrated into modules helped overcome fatalistic beliefs about cancer [14]. The design of a breast examination awareness app was guided by a qualitative study conducted in Malaysia using the Health Belief Model. The study highlighted the importance of using simple language, visual lessons, reminders, and culturally appropriate content when creating mobile applications for cancer awareness [15]. The BrAware mobile app, which included dual-language options, culturally relevant content, and reminder functions, was found to significantly improve women's knowledge of breast cancer risk factors, awareness of warning signs, and confidence in breast self-examination in Kelantan, Malaysia. Despite its small sample size and short follow-up, the study emphasizes the significance of culturally customized mobile health technologies in boosting early detection practices [16].

While digital health and e-learning platforms have demonstrated potential in improving cancer awareness and early detection, significant gaps remain at the intersection of health promotion and utilization of web technologies. Few studies have explored how these systems can be engineered for low-resource, multilingual settings, particularly in African contexts, where issues of usability, accessibility, and cultural alignment are critical. Most initiatives focus narrowly on specific aspects of design without delivering truly responsive and universally accessible platforms. In addition, local language integration and broader cultural adaptability are often overlooked, limiting the reach and effectiveness of these tools in diverse communities. This study builds on previous efforts by integrating advanced technologies, user-centered design principles, and culturally sensitive content into a single platform for breast cancer education.

METHODOLOGY

The chosen methodology for implementing the web-based learning platform is the Agile Software Development Model, with a focus on the SCRUM framework. SCRUM provides a structured yet flexible approach to project management by emphasizing iterative development, stakeholder engagement, and continuous feedback through sprint reviews and retrospectives [17,18]. This aligns with the project's need for user-centered design, ensuring that the application evolves based on real-time input from end users and health stakeholders. By adopting Agile, the development process remains adaptive, collaborative, and responsive, ultimately supporting the delivery of a reliable and user-focused e-learning platform for disseminating vital health information.

3.1 System Analysis

In order to effectively encourage early detection and preventative measures, there is still a need for substantial improvements in the breadth, accuracy, and accessibility of information, even while there is some knowledge of the risks

of breast cancer in low- and middle-income nations. A survey of 548 university students reported that 99.3% had heard of breast cancer, but only 67.2% had ever done breast self-examination and just 17.5% had clinical breast examination [19,20]. LMICs currently rely on a mix of community outreach, mass media, Non-Governmental Organization (NGO) - led campaigns, and cultural integration to disseminate cancer awareness. While these approaches raise visibility, they often lack sustainability, inclusivity, and responsiveness, highlighting the need for responsive, multilingual, and culturally adaptable digital platforms

3.2. System Design

Nigeria was employed as a case study in the research design. An oncologist at a cancer treatment facility in Calabar, Cross River State, participated in an unstructured interview. The Calabar-based treatment facility is a cancer clinic center with specialized oncology units, serving an average number of hundred (100) patients annually and providing diagnostic, surgical, and chemotherapy services. It serves as a major referral center for surrounding communities in Cross River State and neighboring regions. In Human Computer Interaction (HCI), an unstructured interview is a qualitative research technique in which the interviewer leads participants in an unstructured open-ended discussion without strictly adhering to a predetermined list of questions. This approach was taken in order to define the system's requirements. The questions asked were as follows:

1. What challenges do you face when trying to raise awareness about cancer in your community?
2. Have you ever used digital tools or e-learning platforms to support cancer education?

Findings revealed that most women in the locality do not present at the clinic early enough for cancer screening. According to the oncologist, this delay is largely attributed to a lack of awareness about the importance of early detection and the fear of undergoing mastectomy. The expert further explained that cancer information is typically disseminated through counseling sessions conducted during patient consultations. Based on the feedback obtained, the web-based learning platform was designed to feature interactive modules such as multimedia contents. It also features multilingual Support for major local languages (Yoruba, Hausa and Igbo) to enhance accessibility. Figure 1 and 2 provides an abstract representation of data flow, input, and output for the web-based learning platform.

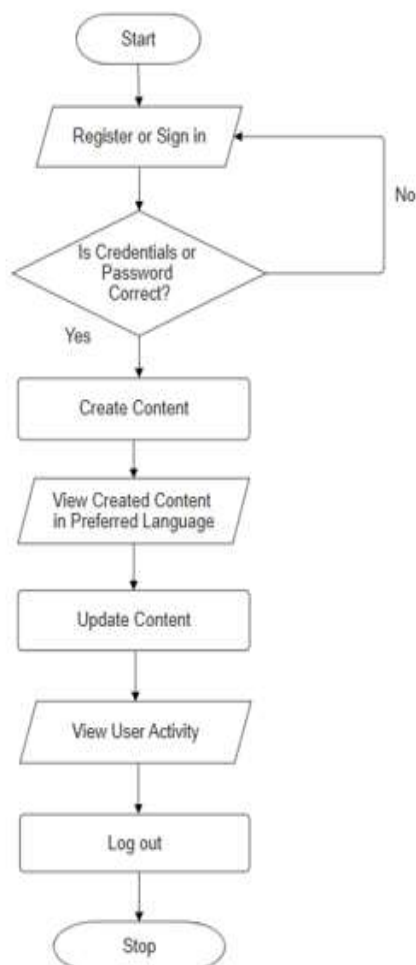


Figure 1: Administrator flow diagram

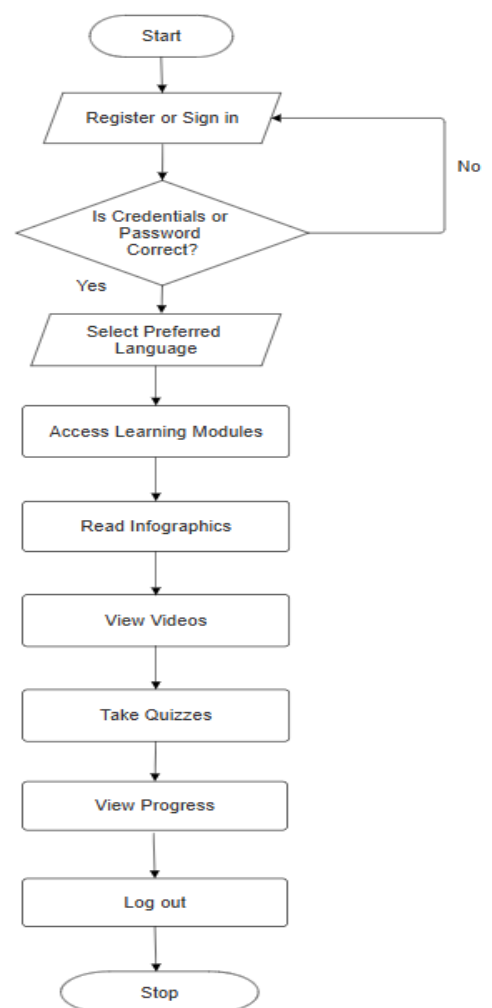


Figure 2: Public user flow diagram

Figures 1 and 2 provide a flowchart outlining the logical processes involved in the user's engagement with the system. It focuses on key components such as user secure authentication, content management, multilingual accessibility, interactive learning materials, performance assessment, progress monitoring, and session control, all of which contribute to a user-centered and secure web-based learning environment. These components show how technology may be efficiently used to provide a safe web-based learning environment while also delivering engaging and inclusive educational experiences, especially in digital health or e-learning contexts. Figure 1 shows the process beginning with the Start node, which represents the system's inception. To utilize the platform's functions, the administrator must first register or sign in. New users can create accounts through registration, while returning users can utilize already created credentials to log in. The decision node then validates the administrator's credentials. If the login and password are input correctly, the system authorizes access, and the process continues. Incorrect credentials, on the other hand, send the user administrator back to the sign-in page to re-enter correct information, maintaining data integrity and safe authentication. After successfully logging in, the administrator can develop new content, such as training modules or informational resources related to the platform's goal. Following content production, the system allows the administrator to examine the information in their choice language, displaying the multilingual functionality that promotes accessibility for varied user groups. The platform also allows the administrator to change existing content, ensuring that the information is correct, relevant, and up to date. This feature facilitates the constant improvement and adaption of educational content. The administrator can then access activity logs to monitor system activities, such as tracking produced or changed material and assessing engagement metrics. Finally, the administrator can log out to securely terminate the session, preserving personal data and system integrity. The procedure ends at the Stop node, which signifies the end of the user interaction sequence.

Figure 2 depicts the process beginning at the Start node, which represents the start of system utilization. To use the platform's features, users must first register or sign in. New users can register to create an account, while returning users can log in using their previously established credentials. A decision node is then utilized to determine whether the entered credentials are valid. If the username or password are incorrect, the system blocks access and returns the user to the login interface for correction. However, if the credentials are verified as valid, the system moves on to the next stage of the procedure. After successful authentication, users are asked to choose their preferred language. This level activates the system's multilingual functionality, allowing users to interact with instructional information in the language they best understand, improving inclusion and comprehension. After selecting a language, customers receive access to learning modules that offer structured educational content. Users can read infographics in these modules, which give summarized visual information intended to clarify complicated health or learning ideas. Following that, viewers are offered the choice of watching educational movies that provide visual and audio reinforcement for the learning information. To measure understanding, the platform features a quiz tool that allows users to take quizzes based on the courses covered. This interactive component encourages active learning and allows users to assess their knowledge retention. After completing quizzes, the system displays a progress screen, allowing users to track their performance and learning development over time. The procedure culminates with the log out stage, in which users securely quit the system while ensuring that their session data and personal information are correctly managed. Finally, the Stop node concludes the user interaction process.

3.3 Database Design

The database, named *cancer_info_db*, is designed around eight core tables that manage users, content delivery, assessments, and system activity. These tables include:

- Users – stores user profiles and authentication details
- Admin – manages administrative accounts and system privileges
- Educational_contents – contains structured cancer-awareness learning materials
- Quizzes – organizes assessments linked to specific educational modules
- Quiz_questions – holds individual questions associated with each quiz
- Progress_records – tracks learner progress and performance metrics
- Content_update_logs – records modifications to educational content for version control
- User_activity_logs – captures user interactions and engagement analytics

Figure 3 depicts a conceptual representation of the *cancer_info_db* database. It provides the various entities and relationships between the tables in the database. This database schema ensures scalability, maintainability, and traceability, while also supporting robust data management and performance monitoring across the platform. The examples of data associated with data fields found in Figure 3 are shown in tables T, 2, 3, & 4.

Table 1 shows the database table structure for users. It is created to store information about system users. This table is designed to manage user information in a secure and structured way. It includes fields for identification (*user_id*), personal details (*full_name*, *Email*), authentication (*password_hash*), authorization (*Role*), and record management (*date_created*). Table 2 defines the structure of a “Content” table which is used to store information about various pieces of content (such as learning materials or media) in a database. This table is designed to manage and store published content in the system. It includes identifiers (*content_id*, *admin_id*), descriptive details (*Title*, *description*), classification fields (*context_type*, *language_code*), and tracking information (*date_published*).

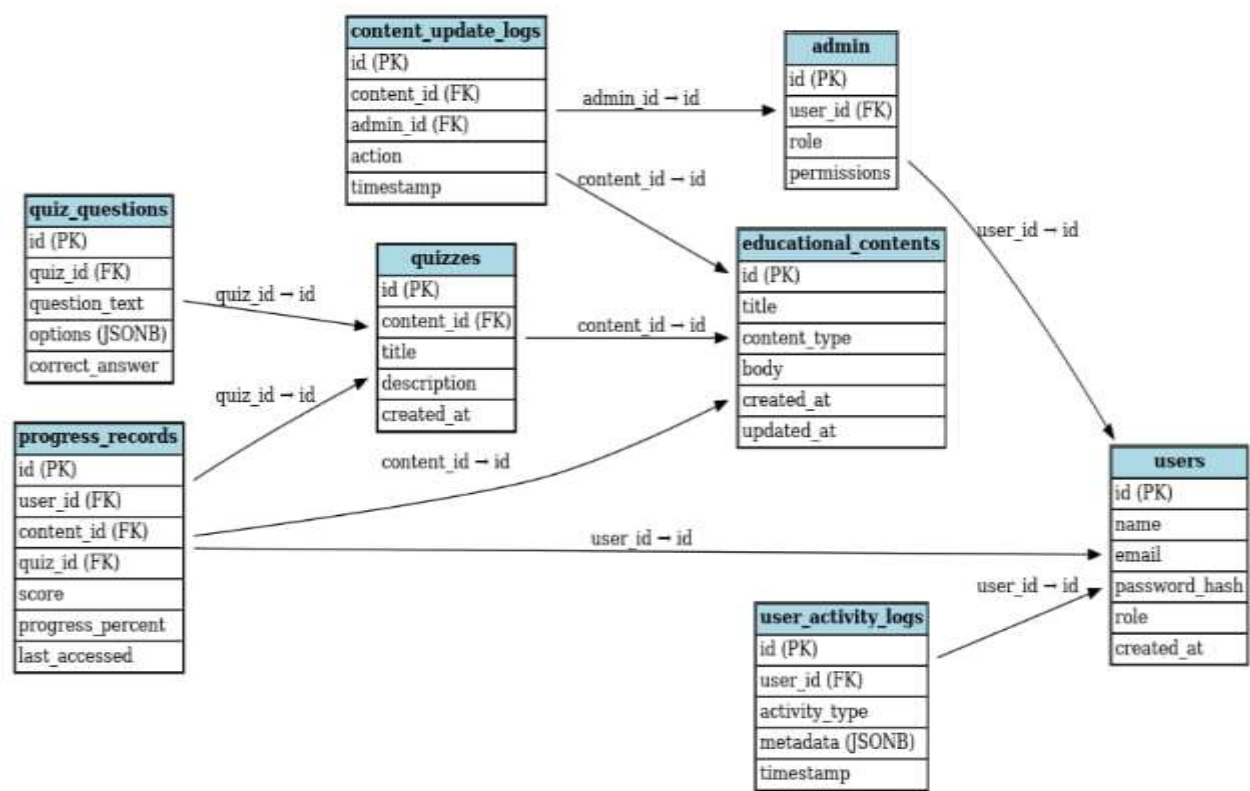


Figure 3: Database Design of web-based learning platform

Table 1: Users table

Field Name	Data Type	Size
user_id	BIGINT	36
full_name	VARCHAR	150
Email	VARCHAR	150
password_hash	VARCHAR	255
Role	VARCHAR	20
date_created	TIMESTAMP	-

Table 2: Educational contents table

Field Name	Data Type	Size
content_id	BIGINT	36
Title	VARCHAR	200
description	TEXT	-
context_type	VARCHAR	20
language_code	CHAR	5
admin_id	BIGINT	36
date_published	TIMESTAMP	-

Table 3 defines the structure of a “Quiz” table, which is used to store information about quizzes or assessments linked to specific content items (such as lessons or courses). This table is designed to manage quizzes related to the educational or training content. It links each quiz to a content record which includes basic identifying information (quiz_id, Title) as well as its scoring limit (total_marks). Table 4 defines the structure of a “User Content Record” table. The table is designed to track user interactions or progress with different content items (such as lessons, videos, or quizzes) in the responsive web-based learning platform. This table is used to track and manage user activity within the platform. It links users to content items, monitors whether they’ve completed them, and logs their most recent access time. It plays a key role in progress tracking and analytics.

RESULT AND DISCUSSION

In this study, the web-based learning platform was designed and implemented to achieve the objectives of developing a responsive web platform for disseminating cancer-related information, implementing multilingual content

delivery for inclusive user reach, evaluating the usability and effectiveness of the platform across various devices as well as demonstrating how web technologies can support public health education in resource-constrained settings.

Table 3: Quiz table

Field Name	Data Type	Size
quiz_id	BIGINT	36
Title	VARCHAR	150
content_id	BIGINT	36
total_marks	SMALLINT	-

Table 4: Progress records table

Field Name	Data Type	Size
record_id	BIGINT	36
user_id	BIGINT	36
content_id	BIGINT	36
completion_status	BOOLEAN	-
last_accessed	TIMESTAMP	-

The implementation of the application required cutting edge technologies to ensure developing a user friendly application. The front end of the study design utilizes Next.js, React and TypeScript for the we-based learning platform while the back end is designed using PostgreSQL, deployed via Supabase, and exposes both REST and GraphQL APIs to support seamless integration with the React-based front end. The front-end technologies were used to build the user interface components because it provides faster updates of the user interface thereby improving the performance of the platform. The PostgreSQL is known for its powerful capability of managing relational databases with structured data. It was used to store user data, quizzes, progress records as well as file URL or paths to multi-media files. Supabase Storage was integrated with PostgreSQL to manage large media files such as images, videos, and PDFs. Files are organized into buckets, which support configurable access controls (public or private), ensuring secure and flexible file management. Designed specifically for handling large files, Supabase Storage is optimized for performance and scalability, making it well-suited for the platform’s multimedia requirements. In addition, Supabase offers simple API access through RESTful endpoints and client libraries, enabling the React front end to seamlessly upload, retrieve, and stream media content with minimal overhead. The Amazon Translate API was integrated into the platform to provide multilingual support, enabling educational content—including text, captions, and quiz questions—to be dynamically translated into local languages such as Yoruba, Hausa, and Igbo. This functionality enhances accessibility by ensuring that diverse user groups, particularly those in low- and middle-income communities who may have limited proficiency in English, can effectively engage with the learning materials.

After implementation of the web-based learning platform, unit testing and integration testing was carried out on the following specification requirements;

- User Authentication: Secure login and profile management.
 - Content Delivery: Dynamic rendering of multimedia educational materials.
 - Progress Tracking: Real-time monitoring of user engagement
- The testing was conducted to ensure that the workability of the application.

The web-based learning platform created, CancerNest, is shown in Figure 4. Women, caregivers, and medical professionals can create accounts on the learning platform using the interface shown in Figure 4, which also makes sure that only users who have registered can use the application.

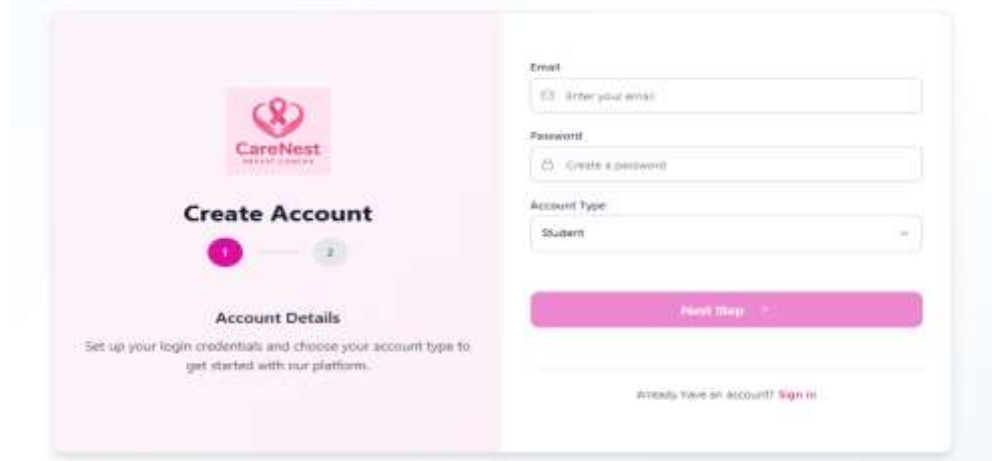


Figure 4: User authentication interface for account creation and access

Figure 5 depicts the user dashboard, which serves as the central interface for learners. It provides access to available learning modules, enables registration for new courses, and allows users to revisit previously completed content. By organizing educational resources in a structured and visually engaging manner, the dashboard supports personalized learning pathways and enhances user experience within the platform.

Figure 6a and 6b depicts the language-toggle capability in action, showing how the dashboard interface easily transitions to another language to serve multilingual users. Users can enroll in several classes and learn them in English, Yoruba, Igbo, or Hausa.

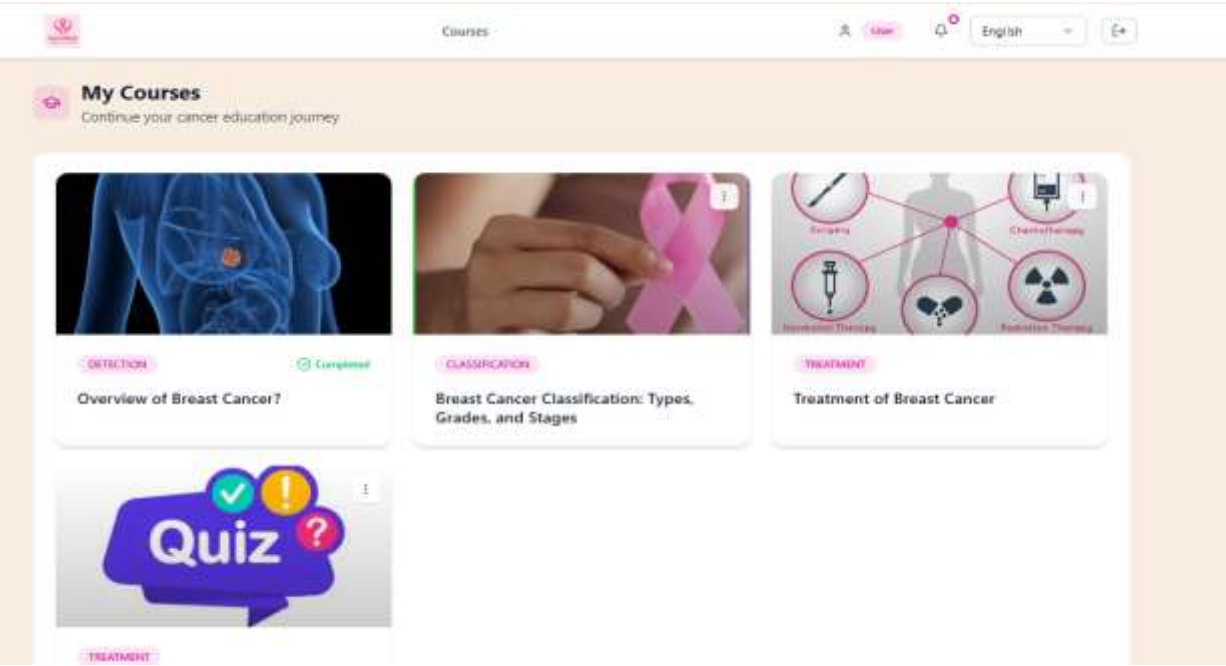


Figure 5: User dashboard

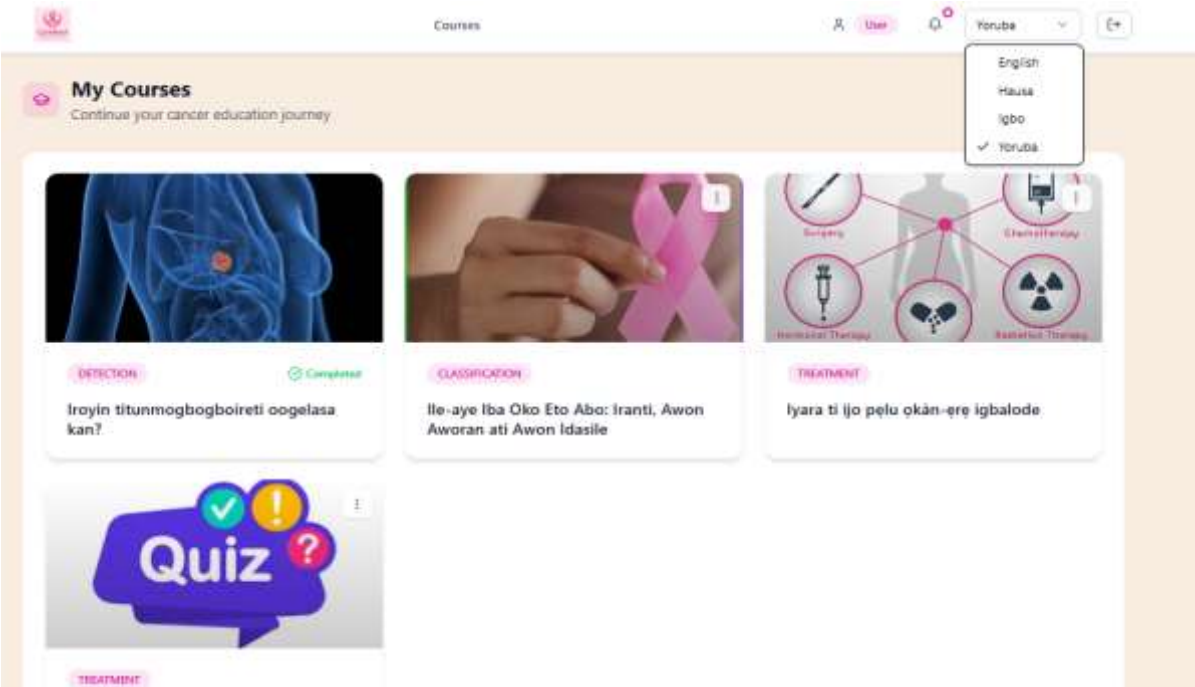


Figure 6a: User dashboard with multilingual support options

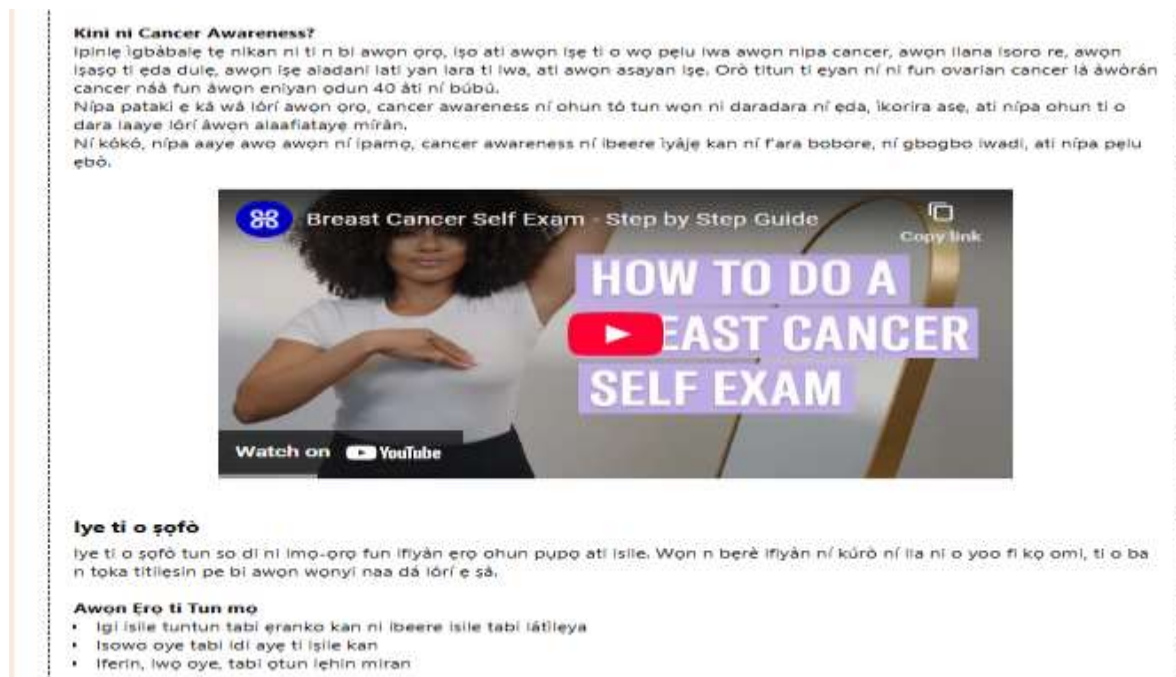


Figure 6b: User dashboard with multilingual support

In Figure 6b, the Natural Language Processing (NLP) feature was implemented using OpenAI API key. The OpenAI API key was incorporated into the project to enable Natural Language Processing (NLP) capabilities that enhance the multilingual functionality, interactivity, and inclusiveness of the responsive web-based learning platform for cancer awareness. The inclusion of the OpenAI API key is justified as it provides the NLP capabilities required to build a multilingual, intelligent, and inclusive learning environment. It enables accurate translation, natural language understanding, and cultural adaptation all of which are essential for delivering effective cancer awareness education to users across different linguistic groups in Nigeria.

Figure 7a and 7b illustrates the admin dashboard for course management. The interface equips administrators with comprehensive control over the web-based learning platform, including the ability to create new modules, update existing content, and organize instructional resources. Beyond content management, it facilitates monitoring of learner engagement and progress, thereby enhancing the system's usability and supporting scalability. This functionality ensures that the platform remains adaptive to evolving user needs while maintaining an efficient and structured learning environment.

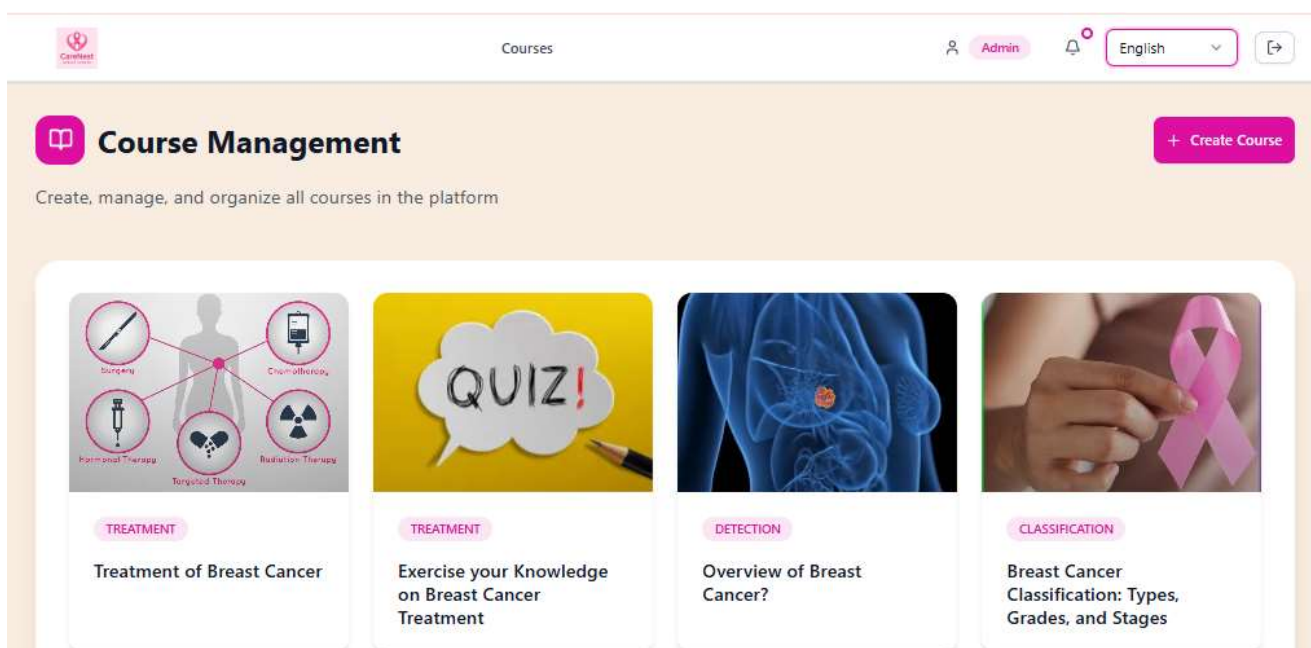


Figure 7a: Admin dashboard for course management

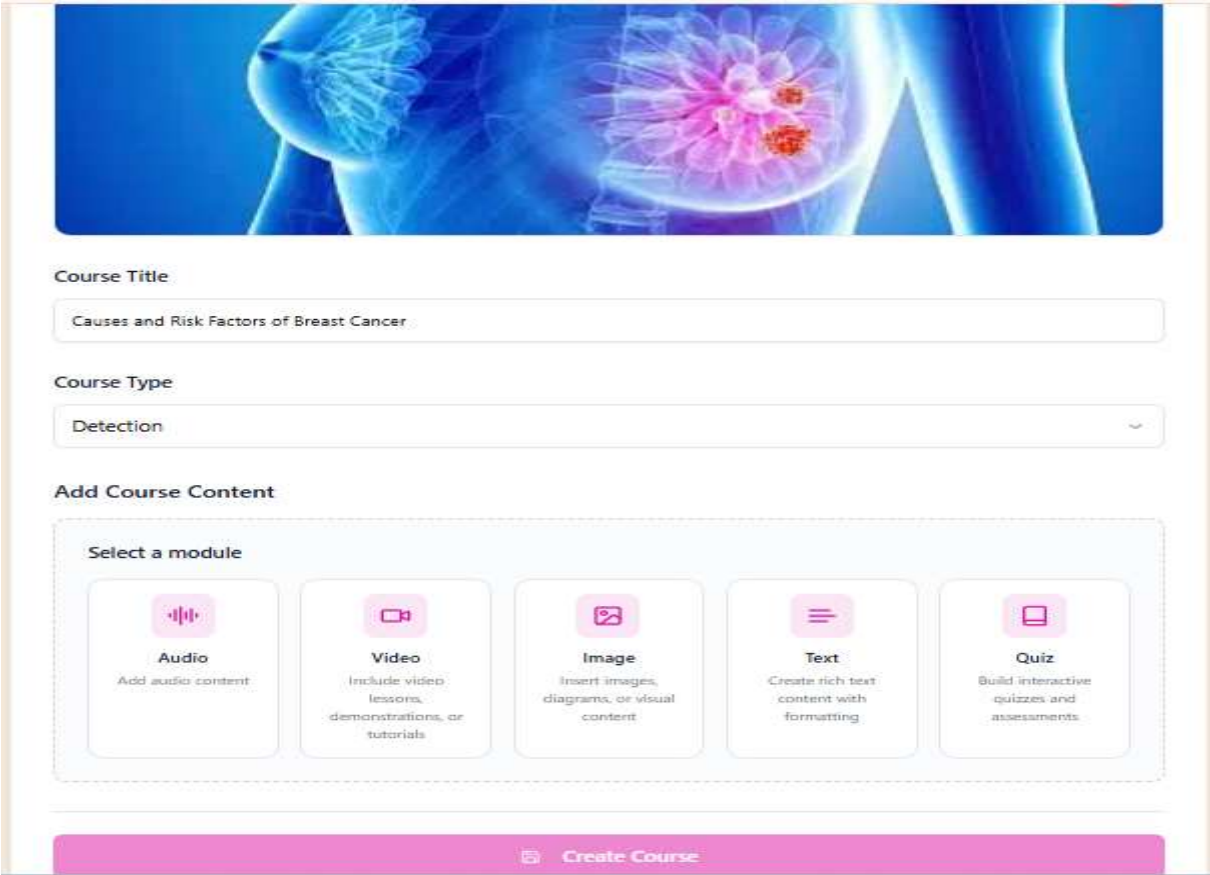


Figure 7b: Admin dashboard for course creation

Figure 8 shows the interface displaying a record of registered users. This dashboard enables the administrator to monitor user enrollment and track the progress of courses taken. It provides real-time feedback by indicating the status of each learner, highlighting those who have completed their courses and those still in progress.

Course Users

Registered Users
6 users enrolled in this course

Fullname	Status	Gender	Age	Score
User 1	COMPLETED	Female	34	
User 2	ONGOING	Female	34	
User 3	ONGOING	Female	32	
User 4	ONGOING	Female	21	
User 5	ONGOING	Female	23	
User 6	COMPLETED	Female	26	

Figure 8: Track record of enrolled users

5. CONCLUSION

This study was effective in building and deploying a responsive web-based learning application to improve breast cancer awareness and early detection, specifically for low- and middle-income nations. The content and resources were created to provide users with knowledge about prevention, early detection, and treatment. This study highlights how digital technology can be utilized to educate the public about important health issues like breast cancer. The study also

demonstrates how a well-designed web-based learning platform may overcome hurdles such as geographic distance, language, and limited access to health specialists. This initiative has added to the expanding body of work on the use of technology for public health education by providing content in an interactive and engaging manner. It also demonstrates how breast cancer education can be given via a user-centered application, particularly in resource-limited situations. The study recommends that health-focused organizations, educational institutions, and non-governmental bodies consider adopting such web-based learning platforms to promote breast cancer awareness. For future enhancement, the platform could incorporate more advanced features such as interactive chat functionality, live consultation sessions with health professionals, and broader support for additional local languages to improve accessibility and user engagement. The platform could also be expanded to cover other forms of cancer or health conditions that require public awareness and education.

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