

Development of an E-Skill Acquisition Information System for Fish Farming

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ABSTRACT

Fish farming is an important source of food, income and employment in Nigeria, but access to structured, timely and practical training remains uneven, particularly for farmers who depend on apprenticeship or occasional physical training. This study presents the development of an E-Skill Acquisition Information System for Fish Farming as a web-based platform for delivering fish-farming knowledge and related services. The Object-Oriented Hypermedia Design Methodology (OOHDM) guided requirements analysis, conceptual design, navigational design, interface design and implementation. The revised system integrates seven core functions: user registration and authentication, administrator management, upload and validation of multimedia learning materials, search and download of approved materials, a virtual fish-farming activity calendar, an E-Sales facility for fish products, and a centralized MySQL database. The database design was normalized and strengthened with explicit primary and foreign keys, realistic field sizes, and a dedicated password-hash field. Security controls include adaptive password hashing, role-based authorization, server-side input validation, protection against SQL injection and cross-site scripting, CSRF protection, controlled file uploads and secure session handling. Functional verification was organized around ten core test cases covering the principal modules. The manuscript's reported successful final verification was reorganized into ten explicit functional test cases; all are recorded as passed, subject to confirmation against the authors' execution logs. The system therefore provides a domain-specific electronic channel through which farmers and prospective farmers can access reusable training resources, production scheduling information and basic market services without relying exclusively on physical training locations.

KEYWORDS: Fish farming; E-skill acquisition; Information system; Digital agriculture; Web-based learning; E-Sales

I. INTRODUCTION

Aquaculture has become an increasingly important component of food production and livelihoods in Africa. Nigeria has substantial water resources and a large domestic market for fish, yet the sector continues to face constraints associated with technology adoption, access to extension services, production inputs and technical knowledge (Kaleem & Bio Singou Sabi, 2021; Ogunji & Wuertz, 2023). The Food and Agriculture Organization also emphasizes the importance of innovation, knowledge dissemination and value-chain development in expanding sustainable aquaculture production (FAO, 2022). Access to information is particularly important because fish farming requires timely decisions on pond preparation, stocking, feeding, water-quality management, disease control and harvesting. Nigerian studies show that fish farmers use mobile phones, radio, television and other information and communication technologies (ICTs), but the intensity of use is constrained by factors such as cost, infrastructure and limited access to relevant digital content (Omotesho et al., 2019; Oke et al., 2021; Oke et al., 2022). More broadly, the digitalization of agriculture in Nigeria has created opportunities to improve information access,

farmer-extension linkages and market participation, although gaps remain in rural infrastructure, digital skills and the availability of context-specific applications (Izuogu et al., 2023).

Technology applications in aquaculture have also expanded beyond basic communication. Contemporary research describes the use of ICT, Internet of Things devices and artificial intelligence for monitoring water quality, feeding, traceability and other production variables (Bernal-Higueta et al., 2023). However, many of these applications are production-monitoring systems rather than accessible skill-acquisition platforms. Likewise, studies on ICT adoption among Nigerian fish farmers mainly measure awareness, usage or economic effects; they do not present an integrated application that combines structured fish-farming training content, reusable multimedia resources, a production activity calendar, role-based content administration and a basic E-Sales function in one platform.

The research gap addressed by this study is therefore the absence, within the reviewed literature, of a lightweight and domain-specific information system that integrates fish-farming learning, scheduling and market-support functions for farmers and prospective farmers. The contribution of the proposed platform is the integration of: (i) structured multimedia learning materials that can be searched, viewed and downloaded; (ii) a virtual fish-farming calendar that links learning to time-sensitive production activities; (iii) an administrator workflow for uploading and validating content; (iv) an E-Sales module for fish-product information and orders; and (v) a centralized database and security layer that manage users, resources and transactions. This combination differentiates the system from general agricultural information channels and from sensor-oriented aquaculture platforms.

The aim of the study is to design and implement an accessible E-Skill Acquisition Information System that supports electronic acquisition of fish-farming knowledge and related services.

The specific objectives are to:

- (a). identify the information and functional requirements of farmers/prospective farmers and system administrators for electronic fish-farming skill acquisition;
- (b). design the system architecture, navigation and interfaces using OOHDM principles;
- (c). implement multimedia learning, virtual calendar, upload/download, user-management and E-Sales functions using web technologies and a MySQL database;
- (d). develop a normalized database structure and security controls for protecting credentials, user information, uploaded materials and transactions; and
- (e). evaluate the implemented system through structured functional test cases that compare expected and observed outputs.

II. RESEARCH METHODOLOGY

The Object-Oriented Hypermedia Design Methodology (OOHDM) was adopted because it separates conceptual modeling, navigation design, abstract interface design and implementation, thereby providing a systematic approach for developing information-rich web applications (Schwabe & Rossi, 1998). The method is appropriate for this system because users must move among related information objects - accounts, learning materials, calendar activities, products and orders - through a web interface.

A. Requirements Analysis and User Roles

Requirements gathering was based on a review of fish-farming information needs reported in the literature and on analysis of the tasks that the intended user roles must perform in the system. The two principal roles are: (a) farmers/prospective farmers, who need to register, authenticate, search for learning resources, view or download multimedia materials, consult the production calendar and place product orders; and (b) administrators, who manage accounts, upload and validate learning resources, maintain calendar information, manage products and inspect stored records. User involvement in the present development was therefore represented through role-based use

cases and task walkthroughs rather than through a formal field survey. A formal farmer usability study is identified later as a limitation and future evaluation activity.

Table 1: Core Functional Requirements of the Proposed System

Component	Primary User	Requirement / Function
E-Skill User	Farmer/ Prospective Farmer	Register, authenticate, manage profile, browse learning resources and access platform services.
Database Administration	Administrator	Manage user accounts, validate content, maintain records, back up data and review system information.
Upload and Validation	Administrator	Upload fish-farming PDFs, images and videos with descriptive metadata and approve content before publication.
Learning and Download	Farmer/ Prospective Farmer	Search by category/keyword, view or stream supported media and download approved materials.
Virtual Calendar	Farmer/ Administrator	Display time-based fish-farming activities such as pond preparation, stocking, feeding and harvesting milestones.
E-Sales	Farmer/buyer	Browse fish products, view price/size information, place orders and inspect order history.
Central Database	System	Persist users, materials, calendar events, products, orders and relationships among records.

B. OOHDM Design and Implementation Stages

The conceptual design stage identified the principal information classes and their relationships. The navigation stage defined how each user role moves among registration, learning resources, calendar and sales functions. The abstract interface stage organized the menus, forms, lists and content views needed to support these navigation paths. The implementation stage translated the design into an operational web application. HTML5 and CSS3 were used for interface structure and presentation, JavaScript and jQuery supported client-side interaction, PHP with the CodeIgniter framework implemented application logic, Apache Cordova was considered for hybrid mobile support, and MySQL served as the backend relational database.

III. SYSTEM ARCHITECTURE AND DESIGN

Figure 1 presents the revised system architecture. The central database is shared by the E-Skill User, Upload and Validation, Learning and Download, Virtual Calendar and E-Sales modules. Farmers interact with the platform through a web or mobile browser, while administrators use privileged management functions. Security controls are applied across the application rather than being treated as a separate login-only feature.

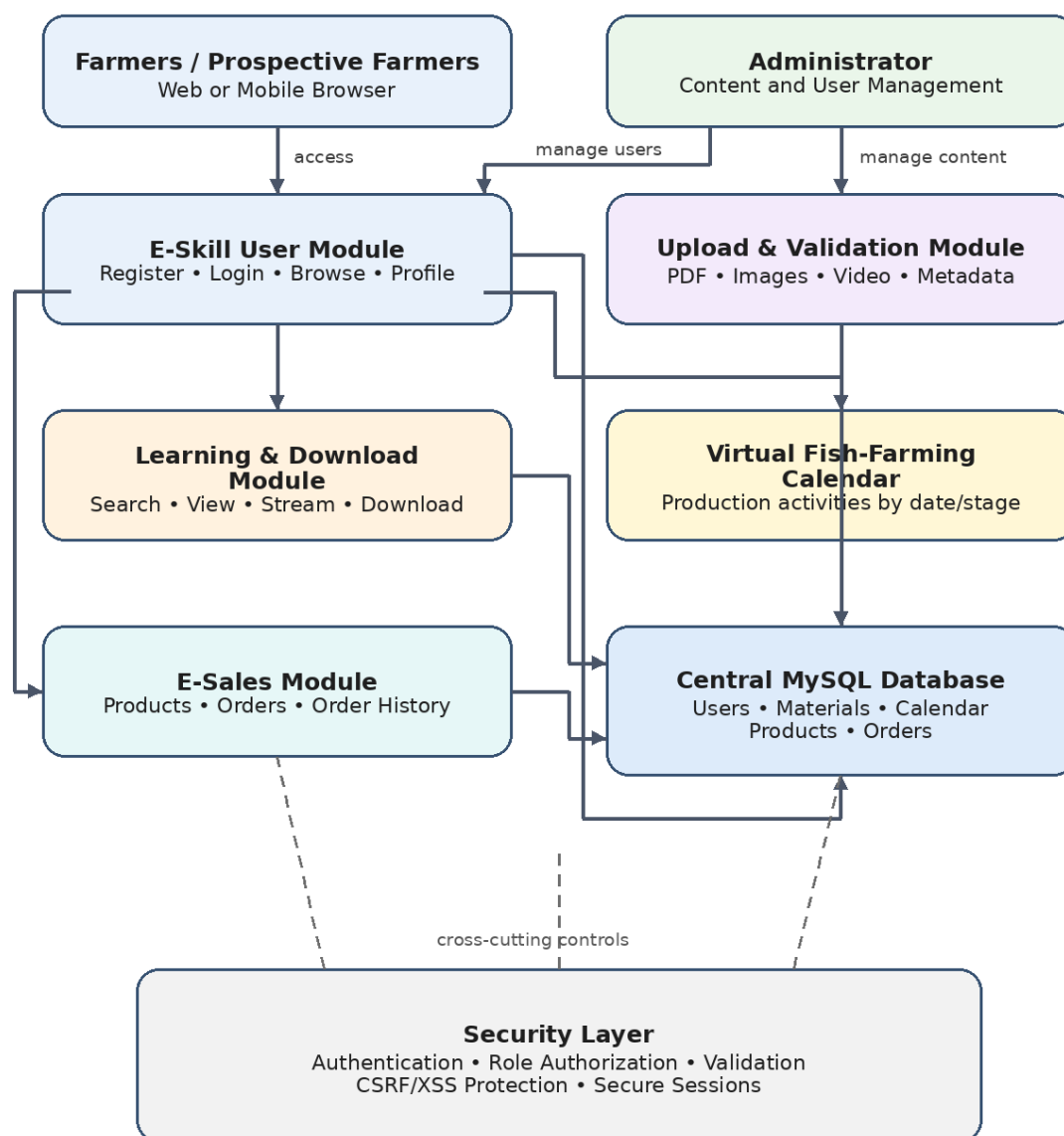


Figure 1: Revised architecture of the E-Skill Acquisition Information System for Fish Farming

A. Database Design and Entity Relationships

The original database specification was revised to use realistic relational data types, explicit primary and foreign keys and a normalized structure. The earlier separation between a basic User table and a member table was removed because it duplicated person-related data. A single Users entity now stores identity, contact and role information. Passwords are not stored as plain text; the schema stores only a password hash. The learning-material location field was expanded from an unrealistic five-character width to VARCHAR(255), while titles, email addresses and descriptive fields were also assigned practical sizes.

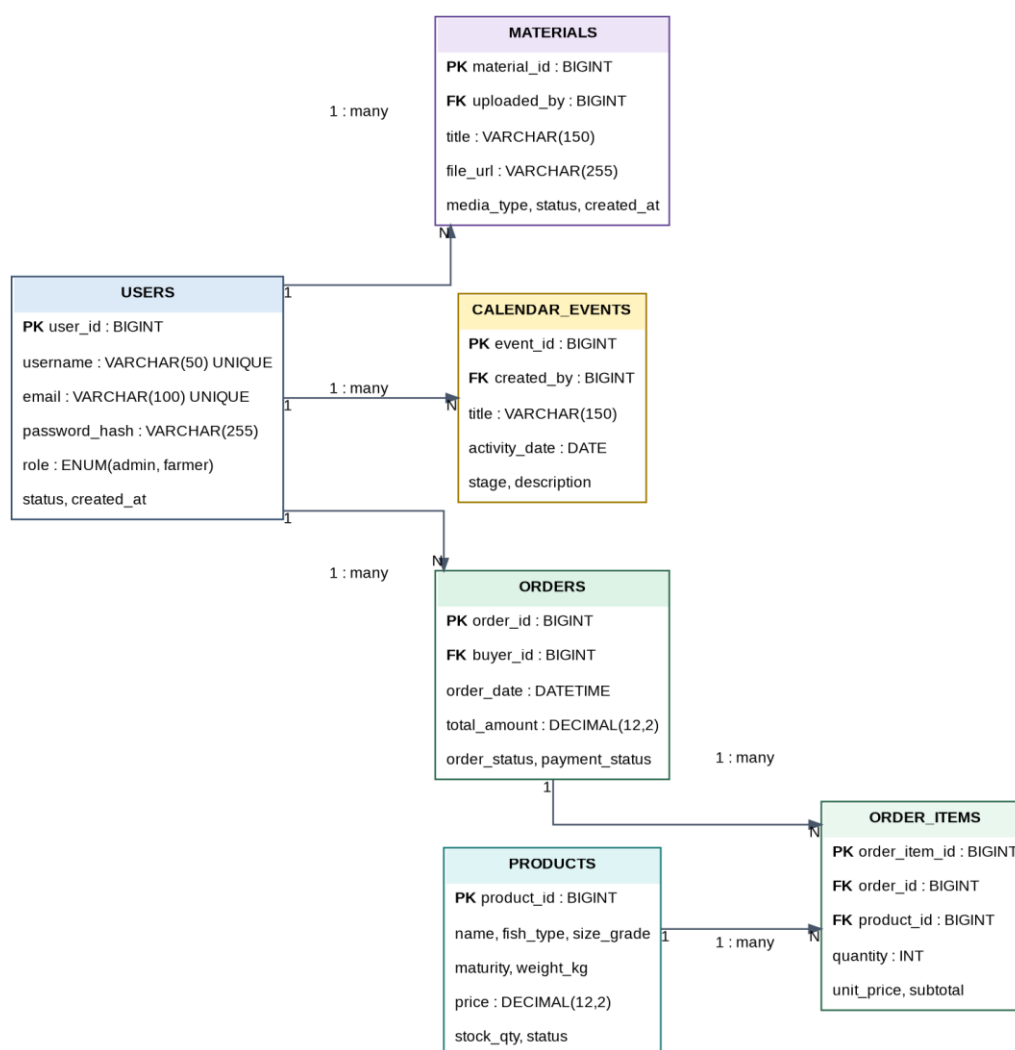


Figure 2: Entity-Relationship Diagram for the Revised Central Database

Table 2: Revised Normalized Database Schema

Entity	Primary key	Foreign key(s)	Important fields / types	Purpose
users	user_id (PK)	-	username VARCHAR(50) UNIQUE; email VARCHAR(100) UNIQUE; password_hash VARCHAR(255); full_name VARCHAR(100); phone VARCHAR(20); address VARCHAR(255); role; status; created_at	Stores farmer and administrator accounts.
materials	material_id (PK)	uploaded_by users.user_id	-> title VARCHAR(150); category VARCHAR(50); description TEXT; file_url VARCHAR(255); media_type; status; created_at	Stores approved/pending skill-acquisition resources and metadata.
calendar_events	event_id (PK)	created_by users.user_id	-> title VARCHAR(150); activity_date DATE; stage	Stores scheduled fish-farming

				VARCHAR(50); TEXT	description	activities and production reminders.
products	product_id (PK)	-		name VARCHAR(100); fish_type VARCHAR(50); size_grade VARCHAR(50); maturity VARCHAR(50); weight_kg DECIMAL(8,2); price DECIMAL(12,2); stock_qty INT; status		Stores fish products offered through E-Sales.
orders	order_id (PK)	buyer_id users.user_id	->	order_date DATETIME; total_amount DECIMAL(12,2); order_status; payment_status		Stores order headers and buyer information.
order_items	order_item_id (PK)	order_id orders.order_id; product_id products.product_id	-> ->	quantity INT; DECIMAL(12,2); DECIMAL(12,2)	unit_price subtotal	Resolves the many-product structure of an order.

Foreign-key constraints enforce referential integrity between users and their uploaded materials, users and orders, administrators and calendar events, and between orders and products through Order_Items. Unique indexes are applied to username and email. Additional indexes can be applied to material category, material status, activity_date and order_status to improve frequently used searches.

B. System Security

Security was strengthened in the revised design because an information system that stores user accounts, uploaded files and sales records must protect confidentiality, integrity and authorized access. The controls were selected to address common web-application risks such as broken access control, cryptographic failures, injection and authentication weaknesses identified by OWASP (2021). Password handling follows the principle that passwords should be stored with adaptive one-way hashing rather than in reversible or plain-text form (OWASP Foundation, n.d.).

Table 3: Security Controls Incorporated into the Revised Design

Control Area	Technical Treatment
Credential protection	Store only adaptive password hashes using PHP password_hash(); verify with password_verify(); password_hash column sized to VARCHAR(255).
Role-based authorization	Enforce server-side checks for administrator-only functions such as user management, content validation and product/calendar maintenance.
Input and database protection	Apply server-side validation and CodeIgniter Query Builder/parameterized queries so user input is not concatenated directly into SQL statements.
XSS and output handling	Escape untrusted output, sanitize rich-text fields where required and reject executable or unsupported uploaded content.
CSRF protection	Use framework-generated CSRF tokens on state-changing forms such as profile updates, uploads and orders.
Session management	Regenerate the session identifier after login; use inactivity expiry and secure/HttpOnly/SameSite cookie attributes when deployed over HTTPS.
File-upload security	Whitelist allowed extensions/MIME types, limit size, rename stored files and prevent uploaded content from executing as server-side code.

**Data/transport
protection**

Use HTTPS in deployment, least-privilege database credentials, backups and restricted administrator access to sensitive management functions.

C. System Process Flow and Implementation

The administrator workflow begins with authentication and proceeds to content and system-management functions. A valid administrator can review existing materials, upload new fish-farming resources, validate resources and maintain related records. Invalid credentials return the user to the login interface without granting privileged access. The user workflow similarly requires authentication before protected resources are opened; after successful login, a farmer can view available learning materials, download resources and access other enabled services such as the virtual calendar and E-Sales.

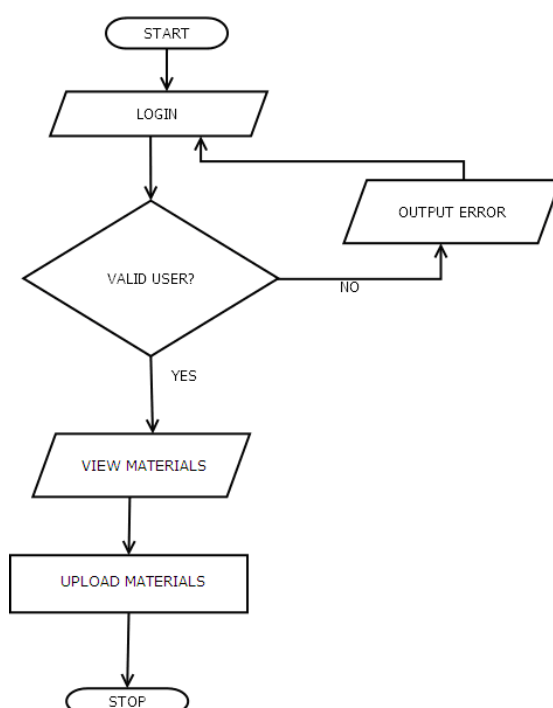


Figure 3: Administrator workflow for authenticated content management

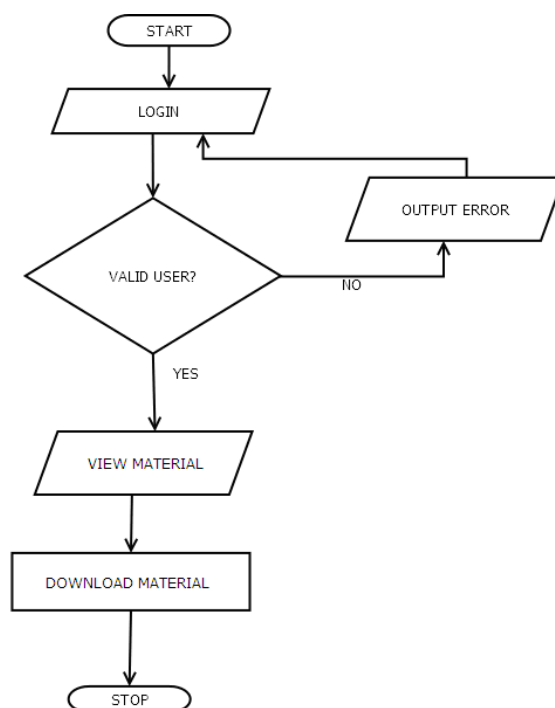


Figure 4: Farmer/User Workflow for Authenticated Access to Learning Materials

The implementation converted the design into a browser-based application using HTML5, CSS3, JavaScript/jQuery, PHP/CodeIgniter and MySQL. Presentation, application logic and data storage were kept as separate layers to improve maintainability. The content-management workflow allows administrators to add fish-farming materials and related metadata, while the farmer-facing workflow emphasizes simple navigation, readable content and downloadable resources that can be retained for later reference.

IV. SYSTEM TESTING AND EVALUATION

Black-box functional testing was used to verify whether the implemented application behaved according to its specified requirements. The original manuscript reports that testing was repeated until identified errors were corrected, but it did not preserve a function-by-function test matrix. To make that reported verification auditable, the revised test plan maps the system's claimed functions to ten explicit test cases covering registration/login, material upload and validation, material download and multimedia access, the virtual calendar, E-Sales, database operations and session termination. The final status in Table 4 is therefore a structured restatement of the manuscript's reported successful final verification and should be cross-checked against the authors' execution logs before submission.

A. Functional Test Results

Table 4: Functional Test Cases and Final Verification Results

ID	Operation	Expected result	Reported final outcome	Status
TC01	Open the application home page	Home page loads and navigation options are available.	Expected outcome achieved in the reported final verification.	Pass*
TC02	Register a new farmer account with valid data	Account is validated and stored with a unique identifier.	Expected outcome achieved in the reported final verification.	Pass*

TC03	Login with valid and invalid credentials	Valid credentials open the correct role; invalid credentials are rejected.	Expected outcome achieved in the reported final verification.	Pass*
TC04	Administrator uploads a fish-farming PDF/image/video with metadata	Allowed file and metadata are stored as a pending/approved material record.	Expected outcome achieved in the reported final verification.	Pass*
TC05	Administrator validates/publishes an uploaded learning material	Approved material becomes visible to authorized users.	Expected outcome achieved in the reported final verification.	Pass*
TC06	User searches, views/streams and downloads approved learning materials	Relevant resources are returned and supported files can be opened or downloaded.	Expected outcome achieved in the reported final verification.	Pass*
TC07	Open the virtual fish-farming calendar	Scheduled activities are retrieved by date/stage and displayed.	Expected outcome achieved in the reported final verification.	Pass*
TC08	Browse E-Sales products and place an order	Product details are displayed and order data are stored with total amount/status.	Expected outcome achieved in the reported final verification.	Pass*
TC09	Create/update/retrieve core database records	CRUD operations preserve keys and relationships without orphaned records.	Expected outcome achieved in the reported final verification.	Pass*
TC10	Logout/end authenticated session	Protected pages are no longer accessible through the previous session.	Expected outcome achieved in the reported final verification.	Pass*

On the basis of the manuscript's reported final successful verification, the reconstructed matrix records 10/10 cases as passed, corresponding to a reported functional conformity rate of 100%. The test set provides explicit coverage of the principal capabilities requiring verification: registration/login, uploading and validating learning materials, downloading/multimedia access, E-Sales, database operations, the virtual fish-farming calendar and session termination. The asterisk denotes that the case-level status is reconstructed from the manuscript's overall testing claim rather than from raw test logs supplied with the manuscript. The percentage should therefore be interpreted as reported functional conformance, not as a user-satisfaction or usability score; the authors should confirm the matrix against actual test evidence before publication.

B. System Software Interface

Figure 5 shows the fish-farming home page used to enter the application. The previous student, teacher, class and subject screenshots have been removed because those interfaces do not represent the fish-farming system. Protected services are accessed through role-based login, and the navigation presented to authenticated users is determined by whether the account is a farmer/prospective farmer or an administrator.

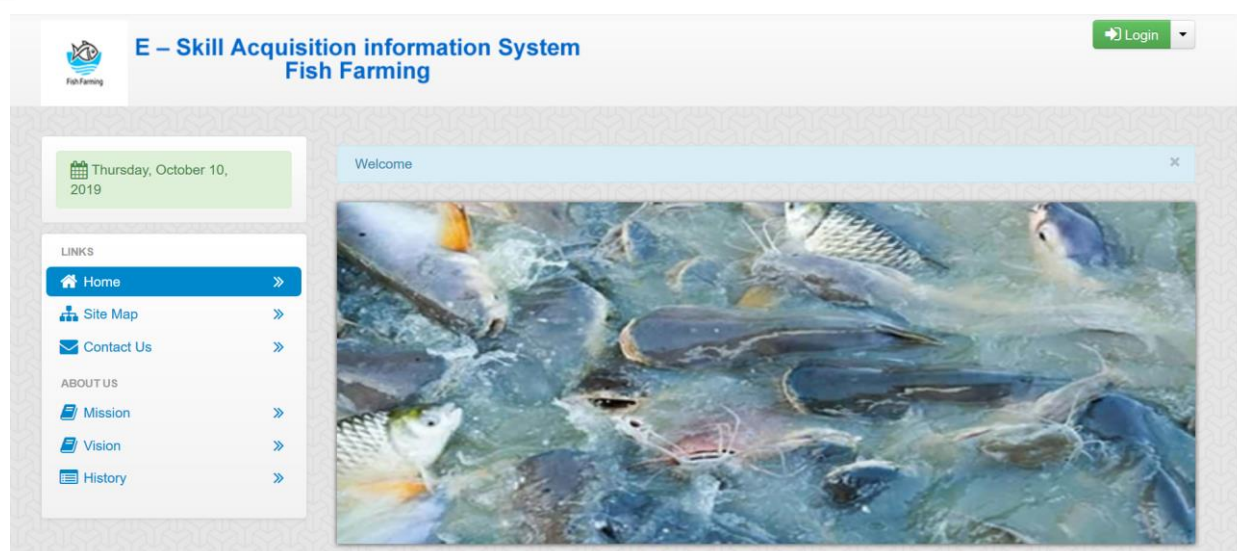


Figure 5: Home Page of the E-Skill Acquisition Information System for Fish Farming

Discussion

The revised system responds to a documented need for improved digital information access among fish farmers. Earlier Nigerian studies demonstrate the relevance of ICT to fish-farm information use, efficiency and profitability but also show that adoption and access are uneven (Omotesho et al., 2019; Oke et al., 2021; Oke et al., 2022). The proposed platform addresses this problem at the application level by organizing fish-farming content into reusable electronic resources and making them available through a role-based web interface. The contribution is distinct from broader digital-agriculture reviews and from precision-aquaculture research. Izuogu et al. (2023) discuss digitalization opportunities and challenges across Nigerian agriculture, while Bernal-Higuita et al. (2023) focus heavily on ICT tools such as IoT and AI for production monitoring and control. In contrast, this system is primarily a skill-acquisition and information-management platform. Its integration of multimedia training, a fish-farming process calendar and E-Sales in the same environment links learning to production timing and basic market interaction rather than treating these functions as separate applications. The revised database and security design also improve the technical credibility of the prototype. Explicit keys and relationships reduce duplication and support referential integrity, while realistic field sizes accommodate actual URLs, email addresses and password hashes. Security is applied at the credential, request, session, database and upload layers rather than relying on username/password entry alone.

Limitations

The evaluation reported in this study is limited to functional verification of the prototype. A formal usability or user-satisfaction study with a defined sample of fish farmers was not conducted; therefore, no claims are made about System Usability Scale scores, learning gains or farmer satisfaction. Future work should include field-based usability testing, accessibility assessment, low-bandwidth performance testing, security penetration testing and evaluation of the E-Sales workflow under realistic transaction volumes. These activities would provide evidence beyond functional correctness and strengthen assessment of real-world adoption.

V. CONCLUSION

This study developed an E-Skill Acquisition Information System for Fish Farming to provide an electronic alternative to exclusive dependence on physical apprenticeship and training locations. The revised platform aligns all of its design, database, security, testing and interface descriptions with the fish-farming domain. It integrates farmer registration and authentication, administrator management, validated multimedia learning resources, search and download functions, a virtual

fish-farming calendar, E-Sales and a centralized relational database. The database was normalized with appropriate key relationships and realistic field definitions, while the security design was expanded to cover password hashing, authorization, validation, session protection, CSRF/XSS controls and secure file handling. The manuscript's reported functional verification was reorganized into ten explicit test cases, all recorded as passed subject to confirmation against the authors' execution logs. The platform therefore demonstrates the feasibility of combining skill acquisition, production scheduling and basic market support in a single fish-farming information system. Future evaluation with actual fish farmers should measure usability, learning effectiveness, accessibility and sustained adoption under field conditions.

REFERENCES

- Bernal-Higuita, F., Acosta-Coll, M., Ballester-Merelo, F., & De-la-Hoz-Franco, E. (2023). Implementation of information and communication technologies to increase sustainable productivity in freshwater finfish aquaculture - A review. *Journal of Cleaner Production*, 408, 137124. <https://doi.org/10.1016/j.jclepro.2023.137124>
- Food and Agriculture Organization of the United Nations. (2022). *The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation*. FAO. <https://doi.org/10.4060/cc0461en>
- Izuogu, C. U., Olaolu, M. O., Azuamairo, G. C., Njoku, L. C., Kadurumba, P. C., & Agou, G. D. (2023). A review of the digitalization of agriculture in Nigeria. *Journal of Agricultural Extension*, 27(2), 47-64. <https://doi.org/10.4314/jae.v27i2.5>
- Kaleem, O., & Bio Singou Sabi, A.-F. (2021). Overview of aquaculture systems in Egypt and Nigeria, prospects, potentials, and constraints. *Aquaculture and Fisheries*, 6(6), 535-547. <https://doi.org/10.1016/j.aaf.2020.07.017>
- Ogunji, J., & Wuertz, S. (2023). Aquaculture development in Nigeria: The second biggest aquaculture producer in Africa. *Water*, 15(24), 4224. <https://doi.org/10.3390/w15244224>
- Oke, F. O., Arowolo, A. O., Olorunsogo, G. O., & Akerele, D. (2022). Information communication technologies utilization and profitability of catfish farming in Ijebu-Ode Zone of the Agricultural Development Programme, Ogun State. *Journal of Agricultural Extension*, 26(2), 53-60. <https://doi.org/10.4314/jae.v26i2.6>
- Oke, F. O., Olorunsogo, G. O., & Akerele, D. (2021). Impact of information communication technology (ICT) and mass media usage on technical efficiency of fish farming in Ogun State, Nigeria. *Journal of Agribusiness and Rural Development*, 2(60), 143-150. <https://doi.org/10.17306/J.JARD.2021.01378>
- Omotesho, K. F., Akinrinde, F. A., Adenike, A. J., & Awoyemi, A. O. (2019). Analysis of the use of information communication technologies in fish farming in Kwara State, Nigeria. *Journal of Agribusiness and Rural Development*, 4(54), 327-334. <https://doi.org/10.17306/J.JARD.2019.01223>
- OWASP Foundation. (2021). OWASP Top 10:2021. <https://owasp.org/Top10/2021/>
- OWASP Foundation. (n.d.). Password Storage Cheat Sheet. OWASP Cheat Sheet Series. Retrieved August 21, 2026, from https://cheatsheetseries.owasp.org/cheatsheets/Password_Storage_Cheat_Sheet.html
- Schwabe, D., & Rossi, G. (1998). An object oriented approach to web-based applications design. *Theory and Practice of Object Systems*, 4(4), 207-225. [https://doi.org/10.1002/\(SICI\)1096-9942\(1998\)4:4<207::AID-TAPO2>3.0.CO;2-2](https://doi.org/10.1002/(SICI)1096-9942(1998)4:4<207::AID-TAPO2>3.0.CO;2-2)