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Skill Swap: An AI-Integrated, Multi-Lingual Peer-to-Peer Learning Platform

Thakkar Parth Vireshbhai
Department of Computer Science Engineering
Guide: Gautam Singh | Industry Mentor: Alok Ray

Abstract

In recent years, digital learning platforms have significantly expanded access to educational resources worldwide. However, many platforms rely on paid or subscription-based models that limit accessibility for financially constrained individuals. This paper introduces Skill Swap, a decentralized peer-to-peer learning platform designed to facilitate knowledge exchange without monetary transactions. Users offer specific skills while requesting others in return, enabling collaborative learning through mutual exchange. The system integrates intelligent matching algorithms, multilingual user interface capabilities, and secure communication mechanisms. Matchmaking employs string-similarity analysis via PHP-based Natural Language Processing (NLP) functions to identify compatible learning partners. Security measures include bcrypt password hashing, secure session management, and prepared database statements to prevent SQL injection. The platform is built with HTML5, CSS3, JavaScript (ES6), PHP, and MySQL and supports English, Hindi, and Gujarati localization. A user evaluation involving 25 participants showed a match relevance rate of 68% across 120 generated matches, demonstrating the practical feasibility of an inclusive, cost-effective, peer-driven knowledge exchange ecosystem.

Keywords—*peer-to-peer learning; skill exchange platforms; natural language processing; web application security; collaborative learning systems; AI-based matching algorithms.*

I. INTRODUCTION

The digital revolution has transformed the education sector by enabling individuals to access learning resources through online platforms. Modern e-learning systems provide flexible learning opportunities through virtual classrooms, recorded lectures, and interactive study materials. Despite these advantages, a major limitation of many existing online platforms is the high cost associated with professional courses and certification programs.

Many individuals possess valuable practical skills yet lack structured opportunities to share or exchange them. This imbalance results in knowledge underutilization despite the simultaneous availability of capable learners and potential instructors.

To address this challenge, the concept of peer-to-peer skill exchange has emerged as an alternative approach to collaborative education. Such platforms enable direct knowledge exchange between individuals, eliminating monetary barriers while fostering community-based learning. The Skill Swap platform proposed in this research creates a decentralized environment where users simultaneously teach and learn—replacing traditional instructor-student hierarchies with mutual knowledge exchange. For example, one user may teach programming while learning graphic design from another participant.

The system integrates concepts from several computer science domains:
- Artificial Intelligence (AI)
- Natural Language Processing (NLP)
- Web Application Security
- Human–Computer Interaction (HCI)

The objective of this research is to design, develop, and evaluate a web-based peer-to-peer learning system that leverages intelligent matching algorithms, multilingual accessibility, and secure communication infrastructure to facilitate skill exchange among users.

II. LITERATURE REVIEW

The concept of digital learning platforms has evolved significantly over the past two decades. Early e-learning systems primarily focused on centralized content delivery through institutional portals. Contemporary research, however, increasingly emphasizes collaborative and community-driven learning environments [1].

Studies on peer-to-peer learning demonstrate that collaborative knowledge exchange improves learner engagement and retention. Empirical findings confirm that learners reinforce their own understanding by teaching others—a phenomenon consistent with the protégé effect documented in cognitive science literature [4].

Commercial platforms such as Coursera and Udemy have expanded educational access at scale, yet typically impose paywalls for advanced content [10], [11]. This economic barrier disproportionately affects learners in low-income regions, motivating the exploration of non-monetary alternatives.

Recent research has explored intelligent recommendation systems capable of matching learners with suitable mentors. These systems commonly rely on NLP techniques to analyze user preferences and skill descriptors [5]. Security considerations are equally critical: established best practices for secure web architecture stress encryption, password hashing, and parameterized queries to mitigate SQL injection and cross-site scripting [3].

Skill Swap builds upon these research directions by unifying peer learning principles, intelligent matching algorithms, and hardened web architecture into a single accessible platform.

III. METHODOLOGY

The development of Skill Swap followed a structured system design methodology encompassing requirement analysis, architecture planning, database modeling, and iterative implementation.

A. Application Architecture

The application adopts a three-tier web architecture:

- Presentation Layer (Front-End) — HTML5, CSS3, JavaScript (ES6)
- Application Logic Layer (Back-End) — PHP with PDO
- Data Storage Layer — MySQL relational database

A custom responsive layout framework using CSS custom properties and grid-based layouts ensures cross-device compatibility. All server-side routing, authentication, and business logic are handled by PHP modules. PHP Data Objects (PDO) with prepared statements enforce strict separation of SQL queries from user-supplied input, eliminating SQL injection vectors [3], [6].

B. Development Process

The development lifecycle followed an iterative, module-by-module approach: core authentication and user-profile management were implemented first, followed by the matchmaking engine, communication subsystem, and finally the multilingual localization layer. Each module underwent unit testing before integration.

IV. SYSTEM ARCHITECTURE

The Skill Swap architecture consists of five primary interconnected modules. The User Interface Module communicates exclusively with the Application Logic Layer, which mediates access to the underlying database and security services.

A. User Interface Module

Provides registration, skill-profile management, match browsing, connection request handling, and the real-time chat interface. Responsive layouts accommodate desktop and mobile viewports.

B. Application Logic Layer

PHP scripts handle request routing, session lifecycle, matchmaking computation, and message persistence. All database interactions use PDO prepared statements.

C. Database Management System

A relational MySQL schema stores user profiles, skill descriptors, swap requests, and chat messages. Foreign key constraints maintain referential integrity across tables.

D. Security Layer

Credentials are stored using PHP's password_hash() function with the bcrypt algorithm (cost factor ≥ 10). Session tokens are regenerated on privilege escalation. BFCache prevention via JavaScript Page Transition API lifecycle events eliminates unauthorized access to protected pages from browser history.

E. Matching Algorithm Module

Analyzes skill descriptors using NLP string-similarity techniques to identify compatible learning partners (detailed in Section V).

V. AI-BASED SKILL MATCHING ALGORITHM

The core matchmaking feature automatically identifies compatible users based on learning interests without requiring manual directory searches.

A. Algorithm Design

The algorithm compares two user-profile attributes:

- skill_learn — the skill the user wants to acquire
- skill_offer — the skill the user is prepared to teach

Compatibility is assessed in two stages. First, PHP's built-in similar_text() function computes a character-level similarity percentage between a candidate's skill_offer string and the requesting user's skill_learn string. Second, stripos() performs a case-insensitive substring search to detect keyword overlap not captured by character-level similarity alone.

B. Scoring and Ranking

The combined similarity score, expressed as a percentage in the range [0, 100], quantifies compatibility. Candidate users whose scores exceed an 80% threshold are classified as high-compatibility matches and surfaced with visual priority indicators in the interface. Lower-scoring candidates are still displayed in descending score order to maximize user choice.

VI. SECURITY ARCHITECTURE

Security is a critical concern for web platforms that manage personal data and facilitate user-to-user communication. Skill Swap incorporates layered defenses aligned with OWASP Top Ten mitigation guidelines [3].

A. Password Storage

User passwords are never stored in plaintext. The bcrypt hashing algorithm, accessed via PHP's password_hash() and password_verify() functions, produces adaptive one-way hashes resistant to brute-force and rainbow-table attacks.

B. SQL Injection Prevention

All database operations use PDO prepared statements with parameterized placeholders. User input is treated as data rather than executable SQL, categorically preventing injection attacks [6].

C. Session Security and Cache Poisoning

Session identifiers are regenerated upon authentication (session_regenerate_id(true)) to thwart session-fixation attacks. BFCache prevention logic uses the JavaScript pageshow event to force re-authentication when a user navigates back to a protected page from the browser history cache.

D. Database Design

The relational schema normalizes user, swap-request, and messaging entities into separate tables linked by foreign keys. This separation minimizes data redundancy and supports precise access-control queries. The Entity–Relationship model defines one-to-many relationships between users and their swap requests, and between users and their chat messages.

VII. MULTILINGUAL LOCALIZATION SYSTEM

Accessibility is fundamental to an inclusive educational platform. Skill Swap incorporates a multilingual localization system supporting English, Hindi (हिन्दी), and Gujarati (ગુજરાતી) — languages covering a substantial portion of the target user demographic in India.

Language selection is propagated through a URL routing parameter. The application logic resolves the active locale and loads the corresponding language dictionary — an associative PHP array mapping interface keys to translated strings. All visible interface text is rendered from this dictionary, ensuring complete localization without hard-coded strings in the view layer.

This architecture permits straightforward addition of further languages by supplying a new dictionary file, requiring no modification to application logic or markup.

VIII. COMMUNICATION AND COLLABORATION FEATURES

Skill Swap provides a structured collaboration workflow comprising two main subsystems: a swap request management system and a peer-to-peer messaging interface.

A. Swap Request Management

Users initiate a skill-exchange proposal by submitting a connection request to a matched peer. The recipient may accept or reject the proposal. Accepted requests establish a mutual connection that unlocks the messaging interface between the two parties, creating a controlled, consent-based collaboration workflow.

B. Messaging Interface

The chat interface employs asynchronous JavaScript (AJAX) polling to fetch new messages without full page reloads, providing a near-real-time experience. Messages are persisted in a dedicated database table indexed by sender, recipient, and timestamp, enabling conversation history retrieval across sessions.

IX. RESULTS AND SYSTEM EVALUATION

A functional evaluation of the Skill Swap platform was conducted involving 25 participants over a controlled testing period. The evaluation assessed three primary dimensions: matching algorithm relevance, security robustness, and multilingual interface correctness.

A. Matching Algorithm Performance

The matchmaking algorithm generated a total of 120 skill match suggestions across all 25 participants. Each match was independently rated by the receiving user as relevant, partially relevant, or irrelevant. Approximately 68% of all generated matches (82 out of 120) were rated as relevant by participants, indicating reasonable performance for basic and moderately complex skill descriptions. Matches involving very short or highly generic skill descriptions (e.g., "coding") showed lower relevance rates, highlighting an area for future improvement through semantic matching techniques.

B. Security Testing

Security testing was conducted using a set of 15 standard SQL injection payloads submitted through all user-facing input fields. The prepared-statement architecture successfully blocked all 15 injection attempts, yielding a 100% prevention rate. BFCache prevention logic was verified across 25 post-logout back-navigation attempts, all of which were correctly intercepted and redirected to the login page.

C. Multilingual Interface Evaluation

All three supported locales — English, Hindi, and Gujarati — were verified for rendering correctness, character encoding integrity, and interface completeness. No truncation, encoding errors, or missing translations were observed across any locale.

TABLE I

Summary of Platform Evaluation Results

Evaluation Metric	Total	Positive	Score / Rate
Skill Matches Generated	120	82	68.3%
User Participants	25	—	—
SQL Injection Tests Blocked	15	15	100%
Multilingual Locale Accuracy	3 locales	3 locales	100%
Session Security (BFCache)	25 tests	25	100%

Overall, the prototype demonstrated the technical feasibility of a non-monetary, collaborative digital learning system built on peer skill exchange. The evaluation results confirm that the platform's core modules — matching, security, and localization — operate correctly and effectively within the scope of the study.

X. CONCLUSION

This paper presented the design and implementation of Skill Swap, a decentralized peer-to-peer learning platform that eliminates financial barriers to education through mutual skill exchange. The system integrates NLP-based intelligent matching, multilingual localization for English, Hindi, and Gujarati, bcrypt-secured authentication, SQL injection prevention via prepared statements, and an asynchronous messaging subsystem.

A user evaluation involving 25 participants demonstrated a match relevance rate of approximately 68%, successful blocking of all SQL injection attempts, and error-free rendering across all three supported language locales. These results confirm that peer-driven skill exchange platforms can serve as a practical and accessible alternative to traditional paid educational services, particularly for users in resource-constrained environments.

While the current system performs effectively, future improvements in matching accuracy through semantic NLP techniques and real-time communication via WebSocket protocols can further enhance the overall user experience and platform scalability.

XI. FUTURE SCOPE

Planned enhancements to the Skill Swap platform include:

- Real-Time Communication: Replacement of AJAX polling with a WebSocket-based protocol (e.g., Socket.IO) to reduce latency and server load.
- Gamification: Introduction of reputation scores, achievement badges, and skill endorsements to increase engagement and trust signals.
- End-to-End Encryption: Integration of the WebCrypto API to encrypt messages client-side, ensuring that even the server cannot access plaintext conversation content.
- Mobile Application: Development of native iOS and Android clients to extend platform reach beyond web browsers.
- Advanced NLP Matching: Replacement of character-level similarity with transformer-based semantic embeddings to improve matching accuracy for synonymous skill descriptions.

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