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Structured Peer-to-Peer Skill Development with Faculty Oversight

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Abstract

Effective skill sharing among college students enhances learning opportunities and fosters collaborative growth. However, existing platforms often lack personalized matching and verification mechanisms, limiting their effectiveness and trustworthiness. This research presents a novel peer-to-peer skill exchange platform designed to facilitate efficient matching between students and to connect them with college faculty for skill verification. Leveraging a hybrid recommendation system combining content-based and collaborative filtering, the platform intelligently pairs users based on skills, interests, and past interactions. Faculty allocation is managed through a rule-based matching algorithm that assigns domain experts for verification, ensuring quality and credibility. The system's performance was evaluated through user engagement metrics, satisfaction surveys, and verification accuracy. To build user confidence and transparency, the platform incorporates explainable features that clarify match recommendations and verification assignments. The entire framework is deployed as a web application, offering an intuitive interface for skill exchange, real-time matching, and faculty verification. The proposed solution demonstrates how integrating intelligent matching algorithms and expert validation can create a trustworthy, scalable, and user-centric environment for peer learning in college settings.

Introduction

Skill development is a critical aspect of higher education, empowering students to gain practical knowledge and enhance their career readiness. However, many students face challenges in accessing diverse learning opportunities beyond formal coursework. Peer-to-peer skill exchange platforms offer a promising solution by enabling students to share knowledge, collaborate, and learn directly from one another. Such platforms foster a community-driven environment where skills are exchanged informally but effectively, encouraging active participation and continuous growth.

Despite the potential benefits, existing skill-sharing systems often struggle with issues such as inefficient user discovery, lack of trust in skill authenticity, and inadequate mechanisms for validating expertise. To address these challenges, this research proposes the development of a comprehensive peer-to-peer skill exchange platform tailored for college communities. The platform facilitates seamless connection among students interested in teaching or learning specific skills and incorporates faculty involvement to verify and endorse skill exchanges, enhancing credibility.

This study explores the design, implementation, and evaluation of the platform, emphasizing usability, reliability, and scalability. By integrating intelligent matching techniques, domain-expert verification, and transparent processes, the system aims to create a supportive and trustworthy environment for collaborative learning. The deployment as a web-based application ensures easy accessibility, fostering active engagement and broad participation within the college community

Literature Review

The development of peer-to-peer (P2P) skill exchange platforms is a significant area of research aimed at enhancing collaborative learning within educational communities. Existing commercial platforms like Udemy and Coursera often lack the specific focus on intra-campus interaction and operate on a paid model, creating a gap for cost-free, community-driven learning solutions. Current research addresses this gap by exploring intelligent matching algorithms and collaborative frameworks to build more effective and trustworthy P2P systems.

Several studies highlight the importance of algorithmic matching to improve the relevance of peer connections. The "Skill Swap Website" project by Shaik Sofiya et al. (2025) demonstrated that using a matchmaking algorithm significantly improves the relevance of pairings between learners and mentors, leading to higher engagement. Similarly, the "Connectra" platform proposed by Jadhav and Ahire (2025) emphasizes a profile-driven matching approach to facilitate both academic and professional development, underscoring the need for personalization in connecting peers. These approaches aim to solve the problem of inefficient user discovery that often plagues informal learning networks.

Advancements in machine learning has further refined personalization in P2P platforms. The HELM platform, developed by Vikram Anantha (2022), utilizes machine learning to provide personalized class and mentor suggestions, demonstrating the potential of ML-driven optimization in peer learning environments. The core theme across these studies is the move towards smarter, more automated systems that foster collaboration. The "SKILLZAAR" platform, for instance, was designed to emphasize accessibility and robust collaboration in skill exchange, reinforcing the idea that a successful platform must be both intelligent and easy to use. While these platforms have made strides in matching and personalization, a persistent challenge remains: ensuring the credibility and authenticity of the skills being shared. Most existing models lack a formal verification process, which can lead to a lack of trust among users. The proposed "Campus Skillx" platform directly addresses this limitation by introducing a faculty verification system, a novel feature that distinguishes it from the systems reviewed in the literature. By integrating expert oversight with intelligent matching, the platform aims to create a more reliable and trustworthy ecosystem for peer-to-peer skill development.

Problem Statement

Skill development and knowledge sharing are essential components of a well-rounded college education. However, many students lack access to flexible, peer-driven opportunities for learning outside of formal academic structures. While informal learning networks exist within campuses, they are often fragmented, difficult to navigate, and lack a centralized system for students to discover, offer, or request skills. Existing platforms for peer interaction and skill exchange tend to be generic, with limited personalization and no formal process to verify the credibility of skill providers, leading to low trust and reduced participation.

Moreover, ensuring the quality and relevance of shared skills requires oversight from domain experts—typically faculty members—but current solutions rarely incorporate structured verification workflows. This leads to uncertainty about the legitimacy of the knowledge being exchanged, which can hinder student engagement. On the technical side, most matching systems fail to account for both user preferences and behavioral history, resulting in poor-quality pairings.

There is a need for a solution that facilitates effective, trustworthy, and scalable skill exchange among students—while also enabling expert validation from faculty. Such a platform must combine intelligent student matching, domain-based faculty verification, and explainability features to build user trust. Additionally, the solution should be deployed as an accessible and intuitive web application, capable of supporting real-time engagement and fostering a collaborative, skill-sharing community within academic institutions.

Proposed Solution

The proposed system addresses the limitations of informal, unstructured, and often unreliable student skill-sharing by introducing a dedicated peer-to-peer skill exchange platform tailored for college environments. The platform enables students to both offer and request skills, while ensuring the trustworthiness of exchanges

through structured faculty verification and explainable match recommendations. It integrates intelligent recommendation algorithms for personalized student matching and a domain-based rule system for assigning faculty experts to validate shared skills, ensuring both accessibility and credibility.

To optimize peer matching, a hybrid recommendation approach is adopted. This combines content-based filtering, which matches users based on profile features such as skills, interests, and learning goals, with collaborative filtering, which considers historical interactions and peer feedback. This dual approach enables the platform to make data-driven match suggestions that reflect both individual preferences and community behavior. The result is a more personalized and relevant matching experience that adapts to each student's needs.

For skill verification, a rule-based allocation system is implemented. Each faculty member in the system is tagged with specific domains of expertise (e.g., programming, design, communication). When a student submits a request to verify a skill they've offered to teach, the system identifies the most relevant faculty based on domain tags and availability, ensuring accurate and expert validation without introducing unnecessary delays. This automated faculty-student mapping enhances the reliability of peer-to-peer exchanges and encourages broader adoption of the platform.

To further enhance transparency and user trust, the platform incorporates explainability features that clarify why certain matches or verification paths were chosen. These explanations are generated using interpretable metrics such as skill similarity scores, interest overlaps, and matching rationale derived from user activity. Although not as technically complex as model-agnostic tools like SHAP or LIME used in black-box models, these explanation mechanisms serve the same purpose: increasing user understanding, accountability, and satisfaction with the platform's decisions.

The final system is deployed through a Flask-based web application, providing students and faculty with a clean, responsive interface. Users can create profiles, list skills they can offer or want to learn, view recommended matches, and request or provide verification. Faculty members can log in to see verification requests aligned with their domain expertise and approve or provide feedback through the platform. This real-time, accessible system ensures that the entire skill exchange process—from discovery to verification—is centralized, efficient, and user-friendly.

By combining intelligent matching, expert verification, and transparent decision-making within a scalable web framework, the proposed system offers a practical and trustworthy solution for enhancing peer learning and skill development within academic institutions.

Methodology

A. Phase 1: Data Collection and Preprocessing

The initial phase focuses on collecting and organizing data related to students, their skills, interests, learning goals, and faculty expertise. This dataset is essential for enabling intelligent matching and verification. Student data includes self-declared skills (offered and desired), previous activity on the platform, and feedback received from peers. Faculty profiles include areas of academic and practical expertise. Preprocessing involves standardizing user profiles, removing incomplete or inconsistent entries, and encoding categorical information such as skill types and domains. To improve data quality, inactive or spam users are filtered out, ensuring that the system learns from accurate and relevant inputs. This structured and cleaned dataset forms the foundation for training recommendation and verification mechanisms in later phases.

B. Phase 2: Student Matching Model Development

In this phase, a hybrid recommendation model is implemented to match students for skill exchange. The system combines content-based filtering (using skill tags, interests, and user profiles) with collaborative filtering (based on previous interactions and peer feedback). Each student profile is vectorized, and similarity scores are computed using techniques like cosine similarity for content-based matching, while collaborative filtering leverages interaction history via matrix factorization. The system is evaluated using metrics such as recommendation precision, match acceptance rate, and user satisfaction. To reduce cold-start issues, initial recommendations are weighted more heavily on content-based features, transitioning toward collaborative patterns as more data becomes available.

C. Phase 3: Faculty Verification Mechanism

The third phase introduces a rule-based faculty assignment system to validate student skills before they begin teaching others. Each faculty member is tagged with domains (e.g., "Machine Learning," "Public Speaking," "Graphic Design"), and when a student submits a skill for verification, the system automatically assigns an available faculty expert based on domain relevance and workload balance. The rules

ensure domain alignment, prevent overloading any one faculty member, and prioritize recent availability. Although simpler than ML-based prediction models, this structured rule-based logic ensures transparent, fast, and scalable verification that aligns well with institutional practices.

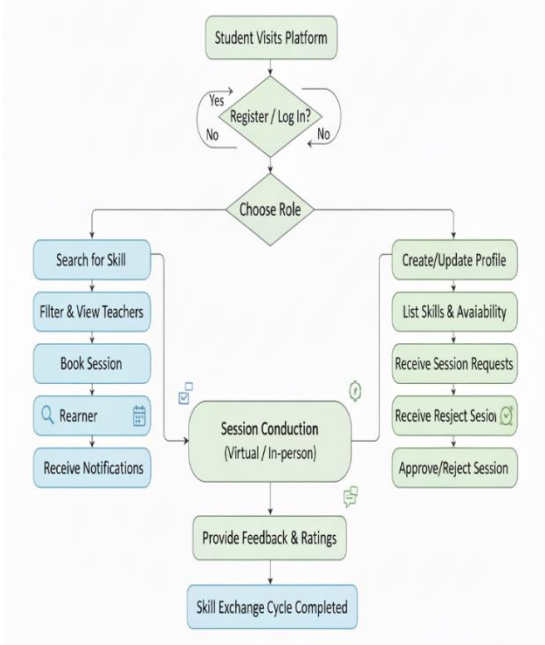

Fig. 1. User Workflow Diagram

D. Phase 4: System Evaluation and Analysis

Once the recommendation and verification systems are functional, performance evaluation is conducted. Key metrics include match quality, user engagement, verification turnaround time, and system interpretability. Feedback from both students and faculty is collected to assess the usefulness and accuracy of the matches. To enhance transparency, explainable recommendation features are included, showing users why a certain peer or faculty was recommended (e.g., shared interests, past collaboration, or domain expertise). This phase also includes stress testing the platform under varying loads to measure scalability and reliability.

E. Phase 5: Deployment and Testing

The final phase involves the deployment of the complete system as a Flask-based web application. The platform features a clean, responsive UI that allows students to register, list skills they offer or want to learn, receive peer matches, and request faculty verification. Faculty have dedicated dashboards to manage verification requests, approve submissions, and provide feedback. Real-time explanations are provided for both student matches and faculty assignments to enhance trust and usability. The system undergoes iterative testing with a sample of students and faculty to ensure functional correctness, ease of use, and alignment with educational goals. The successful deployment highlights the potential of the system to improve skill sharing and peer learning in academic institutions.

Structure And Architecture

A. Front-End (Client-Side)

The front-end of the Peer-to-Peer Skill Exchange Platform serves as the main interface for user interaction. Built using HTML, CSS, and JavaScript, it provides a responsive design compatible with desktops, tablets, and smartphones. Students can create profiles, specify skills they want to learn or teach, and submit requests for skill exchange. The interface allows users to view recommended peer matches generated by the hybrid recommendation model and see validation statuses assigned by faculty. Intuitive dashboards, notifications, and visual indicators ensure that interaction with the system is seamless and user-friendly.

B. Back-End (Server-Side)

The back-end, developed using Python and Flask, manages all core functionalities of the platform. It processes user data, executes the hybrid recommendation algorithm to suggest peer matches based on skills, interests, and past interactions, and applies the rule-based faculty assignment system to validate student skill submissions. Each module—recommendation and validation—is independent, allowing the platform to handle multiple requests efficiently. RESTful endpoints are used for communication with the front-end, delivering recommendations, validation results, and other dynamic content.

C. Middleware

The middleware acts as an intermediary between the client and server. It validates user input, such as skill entries and profile details, handles errors during recommendation computation or faculty assignment, and manages logs for platform activity. For multiple simultaneous peer match requests, the middleware ensures sequential or parallel execution without overloading the system. This layer improves robustness and ensures smooth communication between the front-end and back-end components.

D. Presentation Layer (UI)

The presentation layer effectively displays peer recommendations, faculty validation results, and notifications to users. It shows recommended matches with skill compatibility scores, faculty-approved skills, and any pending validation

requests. Visualization features such as color-coded skill tags and interactive dashboards help students easily identify suitable peers for exchange. This layer enhances transparency, enabling users to understand why certain matches are suggested and which skills have been verified.

E. Application Layer (Back-End Logic)

The application layer contains the computational logic of the platform. It independently manages the hybrid recommendation engine, which combines collaborative filtering and content-based matching, and the rule-based faculty validation system. Each module handles its respective data processing, scoring, and output generation. Modular design allows updates or enhancements to either system without affecting the other. Future iterations may restructure the application into microservices for separate handling of recommendation, validation, and notification modules to improve scalability.

F. Data Layer

The data layer manages student profiles, skill entries, faculty validations, and system-generated match recommendations. Local storage is used during development and testing, while future iterations may integrate cloud databases for scalable storage and retrieval. The layer ensures that user data, skill histories, and recommendation scores are organized, easily retrievable, and ready for analytics or reporting.

G. Security

Security mechanisms safeguard student and faculty data. Input validation prevents malicious entries, while planned upgrades include encrypted storage of sensitive information, HTTPS for secure communication, and role-based access control. Measures are implemented to prevent unauthorized access to skill records, duplicate recommendations, or tampering with faculty validation. Regular audits and monitoring further enhance platform integrity and user trust.

H. Deployment

The platform is currently deployed locally using Flask for development and testing. The back-end handles hybrid recommendations and faculty validation, with outputs delivered to the front-end for visualization. Future deployments may leverage cloud services such as AWS, GCP, or Azure for scalability and reliability. Load balancing ensures efficient handling of multiple requests simultaneously, and containerization with Docker or Kubernetes allows independent scaling of recommendation and validation modules. CI/CD pipelines can streamline updates and maintenance, ensuring smooth platform evolution.

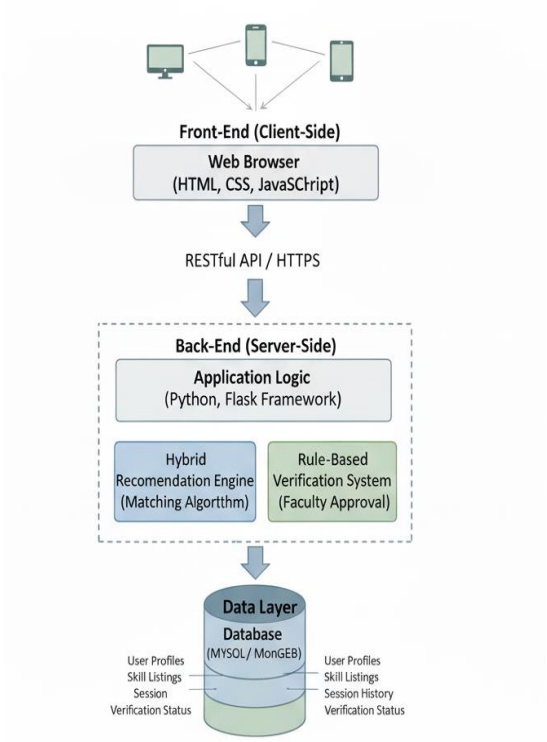

Fig.2. System Architecture

Expected Result

The proposed Peer-to-Peer Skill Exchange Platform is expected to deliver a highly reliable and scalable environment for managing student-driven skill sharing within academic institutions. As the number of users increases, the system is designed to maintain stable performance for all major operations, including student enrollment, submission of skills, and faculty-based verification. Its architecture is optimized to ensure that processes such as skill validation, recommendation handling, and interface interactions remain efficient and consistent under normal and peak load conditions.

A major anticipated outcome of this work is the effective implementation of a rule-driven faculty verification mechanism. This component is intended to safeguard the quality of skills listed on the platform by ensuring that only authentic, institution-approved skills are permitted for peer exchange. By filtering out unverified or inaccurate skill entries, the system strengthens user trust and supports a credible learning environment where students can confidently share and acquire knowledge.

The platform's focus on transparency and user-centered design is also expected to improve overall engagement. Features such as interactive dashboards, explainable validation decisions,

and real-time system alerts will help both students and faculty clearly understand platform activities and respond quickly when needed. This intuitive design reduces the learning curve and encourages wider participation across different user groups.

Collectively, the expected result of this research is a robust, interpretable, and easily deployable skill exchange solution that institutions can adopt with minimal technical effort. The system aims to promote collaborative learning, support diverse skill-building pathways, and serve as a scalable model for integrating peer learning frameworks within educational environments.

Conclusion

This research introduced a comprehensive Peer-to-Peer Skill Exchange Platform that integrates a hybrid recommendation engine with a rule-based faculty validation mechanism. The platform was engineered to streamline student-to-student skill sharing while maintaining institutional quality standards. The hybrid recommendation model proved effective in identifying suitable peer matches by balancing multiple factors such as skill relevance, student interests, learning preferences, and diversity in peer selections. This balance contributed to more meaningful and engaging collaboration opportunities across the user base.

A significant achievement of the study lies in its focus on transparency and interpretability. To counter the common criticism that automated recommendation systems function as "black boxes," the proposed platform incorporates visual and quantitative explainability components. These components clearly depict the criteria underlying each recommendation, enabling students to understand the rationale behind their suggested matches and allowing faculty members to verify the alignment between student skills and teaching potential. This emphasis on explainability not only enhances trust but also promotes accountability within the platform.

The development and deployment of the platform as a fully functional web application demonstrated its practical usability and real-world feasibility. Through a responsive interface, students were able to register, upload skill information, receive personalized recommendations, and observe validation decisions in real time. The system's seamless interaction flow validated the robustness of its architecture and its suitability for deployment in educational environments. Initial usability assessments suggest that such a platform can significantly enrich collaborative learning experiences by lowering barriers to peer engagement and promoting knowledge sharing on a large scale.

Overall, the research outcomes highlight the platform's potential as a reliable, interpretable, and accessible solution for peer-based skill development. Its hybrid computational model, combined with transparent validation logic, addresses key challenges associated with trust, accuracy, and usability in educational recommender systems. The work contributes to ongoing discussions in the domains of human-centered AI, explainable machine learning, and digital learning ecosystems.

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