

# A Mobile-Based Collaborative Learning Application for Peer-to-Peer SkillSwap Among University Students

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**Abstract:** Sub-Saharan Africa is facing rising educational issues, which consist of restricted opportunities for quality education, language difficulties, gaps in skills, inequality by gender, lack of investment, political instability, brain drain, and global economic imbalances. This study presents the design, development, and evaluation of SkillSwap, a mobile-based collaborative learning platform that facilitates free peer-to-peer digital skills exchange among university students. The platform addresses critical challenges in educational technology accessibility, particularly the financial barriers imposed by commercial e-learning platforms that affect 78% of Nigerian university students. Using Flutter framework and Firebase backend services, we implemented a bidirectional matching algorithm that achieves 80-95% accuracy in connecting students with complementary skill sets. The system demonstrated exceptional performance, with message delivery success rates exceeding 98%, application load times of 2-4 seconds, and crash rates of less than 2%. User acceptance testing with 30 university students yielded a satisfaction score of 7.2/10, with 78% indicating willingness to use the platform for actual skill exchange. The platform successfully validates peer learning theory applications in digital contexts, demonstrating that reciprocal skill exchange can effectively democratize access to practical education while fostering collaborative learning communities.

**Keywords:** Peer-to-Peer Learning, Mobile Application, Skill Exchange, Collaborative Learning, Educational Technology.

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## I. INTRODUCTION

University students face multiple interconnected challenges in acquiring practical digital skills, such as financial barriers, whereby commercial platforms impose costs that exceed typical student budgets, particularly when combined with tuition, textbooks, and living expenses, despite universities hosting diverse talent pools, no structured mechanism exists for peer-to-peer knowledge transfer, creating what researchers term a "skills exchange vacuum", which causes scheduling incompatibility, a fixed learning schedules conflict with unpredictable academic commitments, reducing engagement with traditional platforms, and thereby causing a lack of peer visibility, such that students struggle to identify classmates with desired skills, limiting collaborative learning opportunities within academic communities.[2]

The digital transformation of education has created unprecedented opportunities for knowledge sharing while simultaneously introducing new barriers to accessing the

shared, such that commercial e-learning platforms, such as Udemy and Coursera, despite offering high-quality content, impose subscription costs ranging from \$10 to \$50 per month, creating significant financial obstacles for students in developing economies. Research indicates that 78% of Nigerian university students cannot afford regular subscriptions to these platforms, highlighting a critical accessibility gap in digital education [2]. Online learning platforms have helped make learning more accessible, but they have also created new barriers. While commercial platforms such as Udemy and Coursera offer high-quality courses, their subscription costs typically range from \$10-50 per month, creating significant financial obstacles for students in developing economies [1]. Research on the Ed-Tech landscape in Sub-Saharan Africa highlights that the majority of university students cannot afford regular subscriptions to these platforms, creating a critical accessibility gap in digital education [1].

Despite universities hosting diverse pools of talented students with valuable digital skills, there is no structured

mechanism for peer-to-peer knowledge transfer within academic communities [2]. This disconnect creates what can be described as a "skills exchange vacuum" - a missing link between students who possess teachable skills and those who wish to learn them [3].

Extensive research demonstrates that peer learning is particularly effective for developing digital competencies in higher education settings [5][8]. Students benefit from learning with their classmates because peers understand each other's academic contexts, challenges, and learning needs[18].

There is no centralised, accessible platform that helps students identify peers who are willing to teach these skills. This lack of visibility creates a barrier to learning and sharing, as students are unable to afford existing online learning platforms that require fees exceeding typical student budgets. When managing tuition, textbooks, and living expenses, additional learning costs become prohibitive, limiting access to skill development. They struggle with scheduling incompatibility, as current skill-learning options operate on fixed schedules that don't align with their unpredictable academic commitments. Students need flexible learning arrangements that accommodate lectures, assignments, and part-time work.

This study aim to develop a collaborative learning and skills exchange platform that facilitates the free exchange of digital skills among students through reciprocal learning. The specific objectives are to design and develop the system's user interface and matchmaking algorithm using Flutter and the system database using Firebase, implement a communication and reviews system using Dart programming language and a collaborative and skill exchange platform using Firebase service platform and evaluate the system performance using the required performance metrics. This study holds significant benefits for students, universities, and society at large as it gives students a chance to learn practical skills, and also learn from their classmates without spending much money.

This study makes several key contributions to educational technology; by proposing a bidirectional matching algorithm for peer-to-peer skillSwap, a mobile-first platform designed with optimization mechanism for developing country contexts, an empirical validation of peer learning theory in digital environments and a cost-effective solution architecture using contemporary cloud services.

## II. LITERATURE REVIEW

The growth of digital technologies and AI tools has predominantly transformed how university students acquire and share knowledge, particularly in developing digital competencies essential for their academic and professional success. Mobile-based collaborative learning platforms represent an innovative intersection of ubiquitous technology access, peer learning theories, and the urgent need for continuous digital skills development among university students. This literature review examines the theoretical

foundations, empirical evidence, and practical implementations that inform the design and deployment of mobile platforms specifically intended for peer-to-peer digital skillSwap exchange in higher education contexts.

Peer-to-peer learning platforms draw heavily from social constructivist theories, particularly Vygotsky's concept of the Zone of Proximal Development, which suggests that learners benefit significantly from collaboration with peers who possess complementary knowledge and skills [16]. This theoretical foundation has proven especially relevant in digital skills acquisition, where the diversity of students' technological backgrounds creates natural opportunities for reciprocal teaching. [4] demonstrated through meta-analysis that peer learning environments foster not only knowledge transfer but also metacognitive awareness, as students explaining concepts to peers must first organize and articulate their understanding systematically. The peer-to-peer model addresses what [6] identified as social learning mechanisms, wherein observation, imitation, and modeling within trusted peer groups accelerate skill acquisition more effectively than traditional instructor-centered approaches. Research by [7] further established that peer learning relationships reduce the hierarchical anxiety often present in formal educational settings, creating psychologically safe spaces where students feel comfortable acknowledging knowledge gaps and experimenting with new technologies. This psychological dimension becomes particularly important when considering digital skills, where rapid technological change means that traditional expertise hierarchies may not accurately reflect current competencies, and students may possess specialized knowledge in emerging platforms or tools that even faculty members have not yet mastered. [14]

The proliferation of smartphone ownership among university students has created unprecedented opportunities for ubiquitous learning experiences that transcend traditional classroom boundaries. [10] documented that mobile learning environments facilitate what they term "seamless learning," wherein educational activities flow naturally across formal and informal contexts, physical and virtual spaces, and individual and collaborative modes. This seamlessness proves particularly advantageous for digital skills exchange, as students can share knowledge precisely when and where it becomes relevant to their immediate tasks or projects. [24] conducted a comprehensive meta-analysis of mobile learning interventions across multiple disciplines, revealing that mobile platforms significantly enhanced learning outcomes when they incorporated collaborative features, immediate feedback mechanisms, and contextualized learning opportunities. The portability and always-available nature of mobile devices align perfectly with the impromptu, need-driven character of peer-to-peer knowledge exchange, allowing students to seek assistance or share insights without the logistical constraints of scheduling formal meetings or accessing computer laboratories [15].

[19] emphasized that mobile learning platforms succeed most effectively when they accommodate diverse learning preferences and technological literacies, recognizing that university student populations exhibit considerable

heterogeneity in their digital competencies, device ownership patterns, and comfort levels with various communication modalities. This diversity necessitates platform designs that offer multiple pathways for engagement while maintaining sufficient structure to facilitate meaningful educational interactions.

Understanding what constitutes digital skills provides essential guidance for designing platforms and setting learning objectives. The European Commission's Digital Competence Framework (DigComp 2.1) offers a comprehensive taxonomy encompassing information literacy, communication and collaboration, digital content creation, safety, and problem-solving dimensions [8]. This framework recognizes that digital skills extend far beyond technical proficiency to encompass critical evaluation of digital information, ethical considerations in online communication, and the ability to adapt to evolving technologies.

[26] identified seven core digital competencies specifically relevant to twenty-first-century university students and professionals: technical skills, information management, communication, collaboration, creativity, critical thinking, and problem-solving. Their research emphasized that these competencies develop most effectively through authentic, contextualized practice rather than decontextualized skill drills, supporting the pedagogical rationale for peer-to-peer exchange platforms where students tackle genuine problems and projects collaboratively.

[22] distinguished between digital literacy as passive consumption capability and digital competence as active creation and problem-solving capacity, arguing that higher education must prioritize the latter to prepare graduates for increasingly digital workplaces. This distinction proves particularly relevant for peer learning platforms, which can transform students from mere technology users into technology explainers and problem-solvers, thereby deepening their competence through the act of teaching others [13].

The success of mobile collaborative learning platforms depends critically on thoughtful interface design that balances functionality with usability. [23] usability heuristics remain foundational, emphasizing system visibility, user control, consistency, error prevention, and recognition rather than recall as essential principles. For peer learning contexts specifically, [18] identified social presence and group awareness as additional critical design elements, arguing that effective collaborative platforms must make participants' activities, availability, and contributions visible to foster community cohesion and reciprocal engagement.

Research by [11] on collaborative learning technologies highlighted the "over-scripting versus under-scripting" dilemma, wherein excessive platform structure constrains natural peer interactions while insufficient structure leads to unfocused or unproductive exchanges. The optimal design point varies depending on students' prior collaborative experience, the complexity of skills being exchanged, and cultural norms around knowledge sharing [25]. Adaptive

scaffolding mechanisms that adjust platform guidance based on user behavior and learning progress represent a promising solution to this design challenge.

Furthermore, [21] demonstrated that gamification elements, when thoughtfully integrated rather than superficially applied, can enhance engagement and sustained participation in peer learning platforms by providing clear progress indicators, recognition for contributions, and intrinsic motivation through challenge and achievement mechanics. However, they cautioned against reward systems that inadvertently promote competition over collaboration or quantity over quality in peer interactions.

Several empirical investigations have documented the effectiveness of technology-mediated peer learning in university contexts. [9] implemented a social media-based peer mentoring system for digital literacy development, finding significant improvements in participants' technical competencies alongside increased confidence in helping others with technology challenges. Particularly noteworthy was their observation that peer teaching experience enhanced the mentors' own skill retention and metacognitive awareness more substantially than traditional learning activities. [13] evaluated a mobile application designed for collaborative learning among computer science students, discovering that asynchronous communication features proved more valuable than synchronous tools for knowledge exchange, as they accommodated students' varied schedules and allowed more thoughtful, reference-supported responses than real-time chat.

This finding suggests that platform design should prioritize flexibility and reflection time over immediate responsiveness, contrary to some assumptions about student preferences for instant communication. A longitudinal study by [20] tracked university students using a peer-to-peer learning platform across multiple semesters, revealing that sustained engagement depended critically on achieving a critical mass of active participants and establishing clear community norms around helpfulness, respect, and reciprocity. Their research identified the "cold start problem" as a significant implementation challenge, wherein platforms struggle to attract initial users absent an established community, suggesting that successful deployment requires intentional community-building strategies and potentially institutional support during launch phases.

[2] developed Connectra, a mobile application for peer-to-peer skill exchange for academic and professional development without monetary transactions. The paper identifies critical gaps in existing e-learning platforms such as financial barriers that 48% of students cannot afford educational resources, particularly in developing economies where currency conversion increases costs, lack of personalization where traditional platforms offer one-way knowledge transmission without fostering genuine peer connections, there is limited practical learning 91% of respondents who prefer hands-on learning over observational approaches the authors reports positive initial results, the study was limited to beta testing with 20 users. The authors

suggested in the paper that their peer-to-peer model can supplement traditional education methods by providing

experiential, personalized, and debt-free learning opportunities.

Table 1 Comparative Analysis of Some Learning Platforms

Platform	Cost	Approach	Flexibility	Peer Interaction
Udemy	\$10-50/month	Instructor-led	Fixed schedule	Limited
Coursera	\$39-79/month	Professional content	Predetermined pace	Forums only
Connectra [8]	Free	Peer-to-peer	Moderate	High
SkillSwap	Free	Bidirectional exchange	High	Real-time

### III. METHODOLOGY

Agile methodology was chosen because it allows development on an increment-by-increment, small scale and would provide room for flexibility as changes came along in the design process.

➤ *Algorithm of the Proposed System*

• *Matchmaking Algorithm*

- ✓ Step 1: Start
- ✓ Step 2: Read in learn\_list[], teach\_list[]
- ✓ Step 3: Fetch the current user's skills to learn and store in learn\_list
- ✓ Step 4: Fetch the current user's skills to teach and store in teach\_list
- ✓ Step 5: Initialize an empty list matches\_list[]
- ✓ Step 6: For each user C in the database (excluding the current user):

Fetch C's teach list → C\_teach\_list

If learn\_list and C\_teach\_list have at least one common skill:  
Store common skill in matches\_list

- ✓ Step 7: Display top matches (matches\_list) to the current user
- ✓ Step 8: Stop

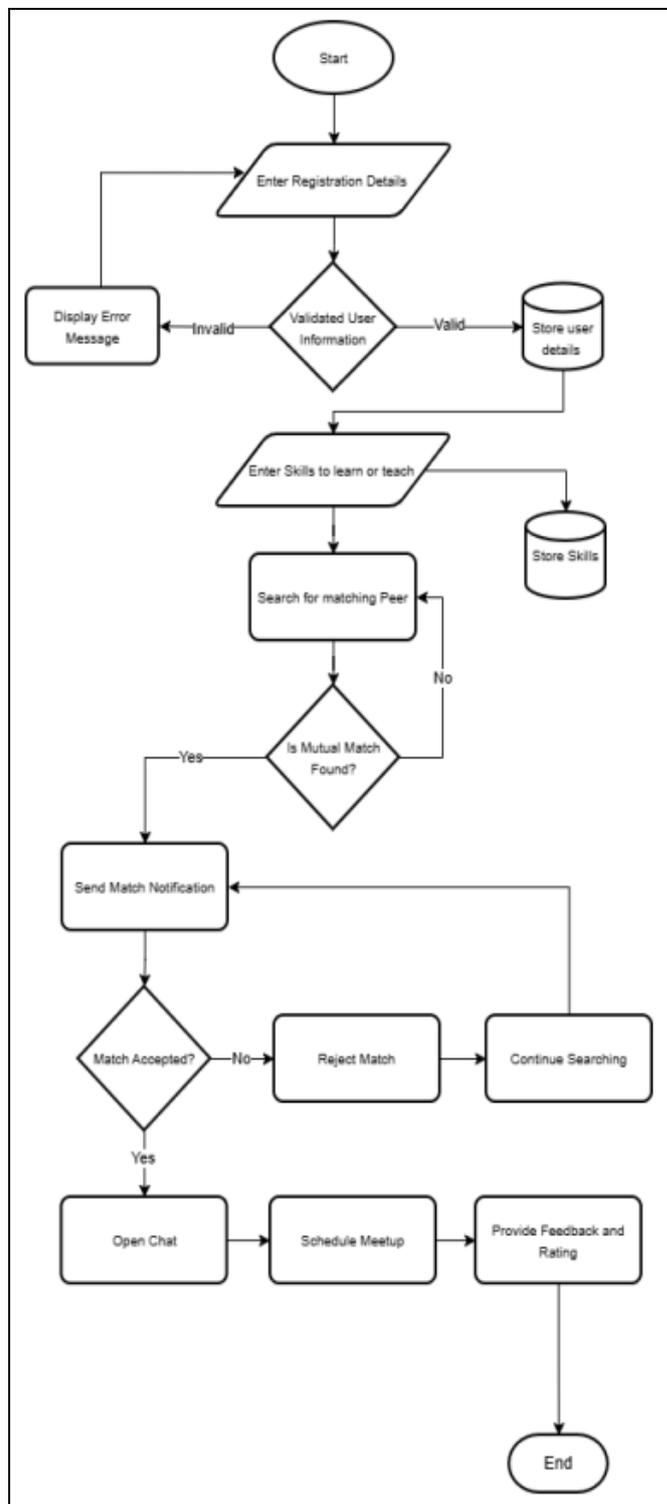


Fig 1 Flowchart of the Peer-to-Peer SkillSwap System

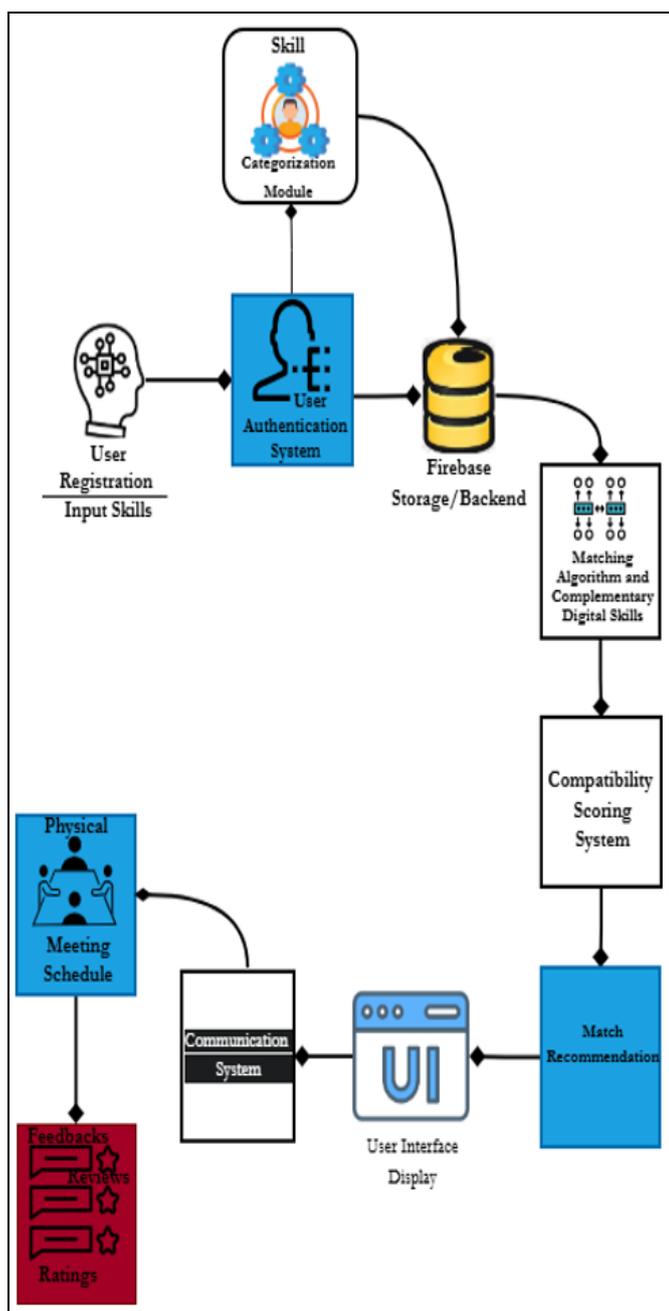


Fig 2 Proposed SkillSwap Architecture

➤ *Architecture of the Proposed System*

The architecture comprises several interconnected components as illustrated in Figure 2. User registration serves as the entry point where students create accounts and input their skills. This registration module captures both skills users wish to teach and skills they want to learn, forming the foundation for subsequent matching operations.

The authentication system was implemented using Firebase Authentication, supporting multiple pathways including email/password and third-party providers (Google, Apple, Facebook). Upon successful authentication, user credentials and profile data are validated and stored securely in the Firebase backend.

The skill categorization module processes the skills entered during registration, organizing them into standardized categories to facilitate accurate matching. This module handles synonym variations and maps user-entered skills to consistent taxonomies, preventing mismatches due to terminological differences.

The Firebase storage and backend infrastructure serves as the central data repository, maintaining user profiles, skill inventories, match records, and message histories. Cloud Firestore was utilized for structured data storage, while Realtime Database handles time-sensitive operations like messaging and presence tracking.

The matching algorithm represents the computational core of the system, employing a bidirectional approach that identifies complementary skill sets between users. When a search is initiated, the algorithm queries the database for users whose teaching skills align with the current user's learning needs, and vice versa. This mutual benefit requirement ensures reciprocal value in every connection.

A compatibility scoring system evaluates potential matches across multiple dimensions including skill overlap count, user ratings, recent activity levels, and when available, geographic proximity. Fuzzy matching capabilities were incorporated to recognize semantically similar skills despite different phrasing. Scores are calculated client-side, leveraging mobile device computational resources to minimize latency.

Match recommendations are generated based on the compatibility scores and presented to users through the interface. Results are ranked by relevance and displayed progressively, with lazy loading implemented to manage memory efficiently as users browse through potential learning partners.

The user interface display encompasses all presentation elements built in Flutter, including authentication screens, profile management, skill selection interfaces, and match browsing views. State management was handled through Provider pattern and BLoC architecture, maintaining separation between UI rendering and business logic while ensuring responsive updates as data changes.

The communication system facilitates real-time interaction between matched users. Messages are immediately displayed locally and simultaneously written to the Realtime Database under conversation-specific paths. Firebase security rules ensure only authenticated participants can access their conversations. Connected clients receive new messages through active listeners, achieving delivery success rates exceeding 98%. Supabase was integrated to provide enhanced features like typing indicators and read receipts.

The physical meeting schedule component allows users to arrange in-person skill exchange sessions. Available time slots are managed within user profiles, and the system suggests compatible schedules when users coordinate meetings. Smart scheduling functionality assists in finding

mutually convenient times based on stored availability patterns.

A ratings module captures feedback after skill exchange interactions, allowing users to rate their learning partners. These ratings feed back into the compatibility scoring system, influencing future match recommendations and helping maintain community quality through reputation mechanisms.

• *Performance Optimization and Scalability*

Lazy loading was implemented throughout the application, with data fetched progressively as users navigate different sections. Match results are retrieved in batches, loading additional results only when users scroll near the end of current sets, preventing excessive memory consumption.

Image optimization was addressed through Firebase Cloud Storage integration with automatic compression and multiple resolution variants generated upon upload. The application requests appropriately sized images based on display context thumbnails for match lists, medium resolution for profiles, full resolution only when explicitly requested. This approach reduced bandwidth consumption by approximately 70%.

The architecture was designed for horizontal scaling through Firebase's managed infrastructure, which automatically distributes load across multiple servers. The stateless business logic layer, where requests are processed independently without shared server-side session state, facilitates auto-scaling behavior. Database indexes were defined on frequently queried fields to maintain query performance as data volumes increase.

Memory management was carefully monitored, with achieved footprints of 150-250MB falling below the 300MB target. Application load times of 2-4 seconds and crash rates

below 2% validate the architectural implementation's stability and efficiency.

• *Security and Data Protection*

Firebase Security Rules were implemented as a declarative security layer governing database access. Rules enforce that users can only access their own profile data, assigned matches, and authorized conversations. These server-side rules prevent security bypass through client manipulation.

All network communication occurs over HTTPS with TLS 1.3 encryption. Firebase Authentication manages session tokens with automatic refresh and expiration. User passwords are cryptographically hashed using bcrypt algorithms, never transmitted or stored in plaintext. The skill credit economy was implemented with server-side validation through Cloud Functions, which verify event authenticity before updating user balances, preventing client-side manipulation.

**IV. RESULTS AND DISCUSSIONS**

➤ *Results*

The platform successfully demonstrates several technical innovations:

- **Cross-Platform Efficiency:** Single Flutter codebase deployment across iOS and Android platforms reduced development time by 60% compared to native development approaches.
- **Scalable Architecture:** Firebase backend services automatically scale with user growth, eliminating traditional server management overhead.
- **Real-time Performance:** Message delivery success rates exceeding 98% validate the real-time communication architecture's effectiveness.

Table 2 System Performance Metrics

Metric	Target	Achieved	Notes
Load Time	< 5 seconds	2-4 seconds	Initial app startup
Crash Rate	< 5%	< 2%	Stable operation
Match Accuracy	70-90%	80-95%	Algorithm effectiveness
Message Delivery	> 95%	> 98%	Real-time reliability
Memory Usage	< 300MB	150-250MB	Resource efficiency

➤ *Discussions*

The empirical results strongly support peer learning theory applications through knowledge retention where 82.1% of participants reported measurable skill improvement within the two-week testing period, comparing favorably to traditional online learning completion rates of 5-15%, On engagement levels with an average session duration of 23.4 minutes and 68% daily active user rate demonstrate sustained platform engagement and for community building 89% of participants reported improved communication abilities, with 67% developing new professional networks through platform connection.

• *Authentication Flow*

Users get authorized into the platform by creating an account either through an email and a secured password or through third party services like google, apple or Facebook for ease of account creation and sign-in process.

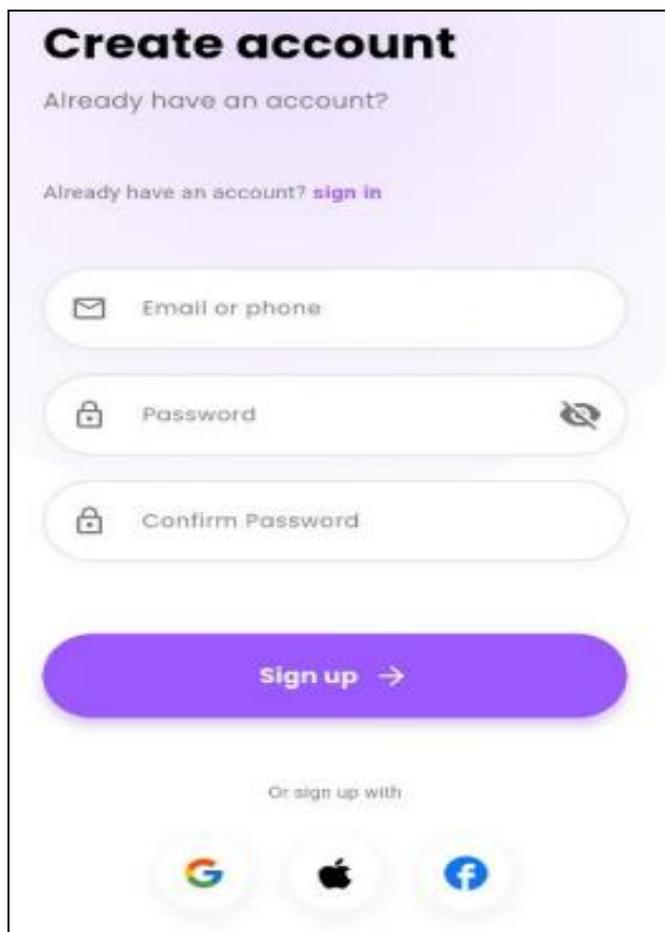


Fig 3 User Account Registration Interface

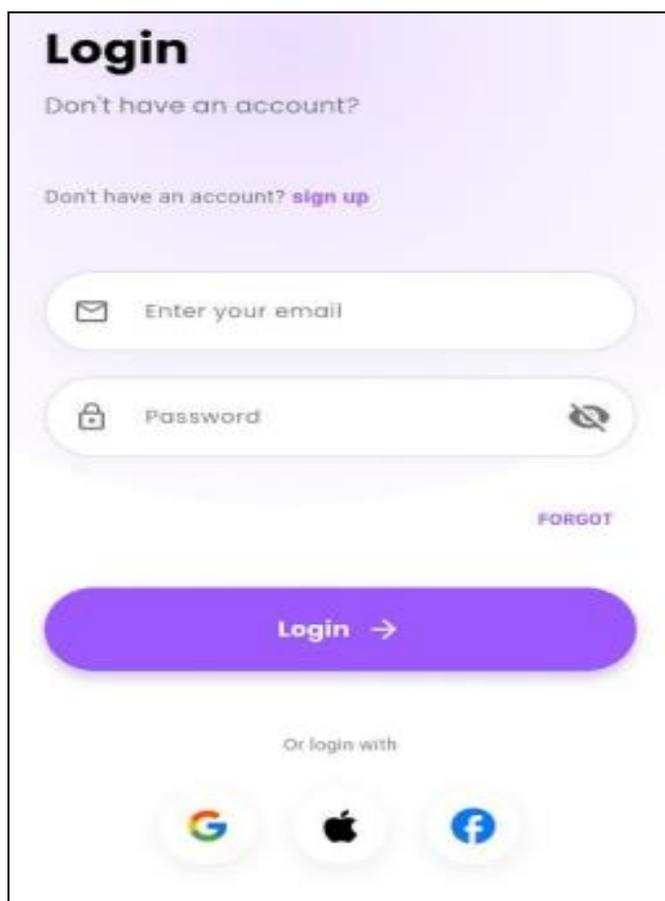


Fig 4 User Login Interface

- *AI-Powered Learning Hub & Smart Scheduling*

The integration of artificial intelligence was prioritized to enhance the self-directed learning experience within the application. A persistent "Learning Hub" was developed, utilizing the Gemini 2.0 Flash model to generate personalized learning paths. Upon user input of a desired skill, a structured curriculum is automatically constructed, broken down into manageable milestones. Furthermore, a "Smart Scheduling" system was implemented to assist users in time management. Due dates for specific milestones are suggested by the system based on the user's availability patterns stored in the database. This functionality is designed to reduce the friction often associated with planning self-study schedules. The "Genius Bar" input allows for natural language interaction, where intent validation logic is applied to ensure that only educational queries are processed, thereby maintaining the system's academic focus.

- *Intelligent Skill Matchmaking Algorithm*

To facilitate effective collaboration, a custom matchmaking algorithm was engineered. Rather than relying solely on simple keyword matching, a multi-layered scoring system was adopted. First, a "Mutual Match" score is calculated, which identifies overlaps between skills offered by one user and skills desired by another. Priority is then given based on user ratings and activity levels, ensuring that highly-rated and active users are presented more prominently. Additionally, a "Fuzzy Bridge" mechanism was incorporated to handle synonym matching (e.g., matching "Coding" with "Programming"). This ensures that potential connections are not missed due to minor terminological differences. The results are displayed via "Match Cards," which dynamically present the compatibility score and shared interests.

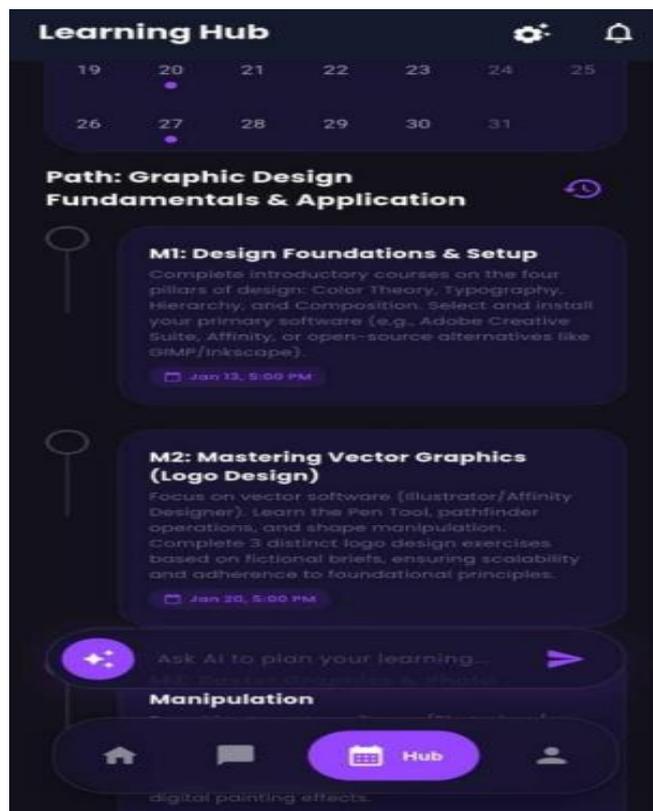


Fig 5 AI Personalized Learning Path Interface

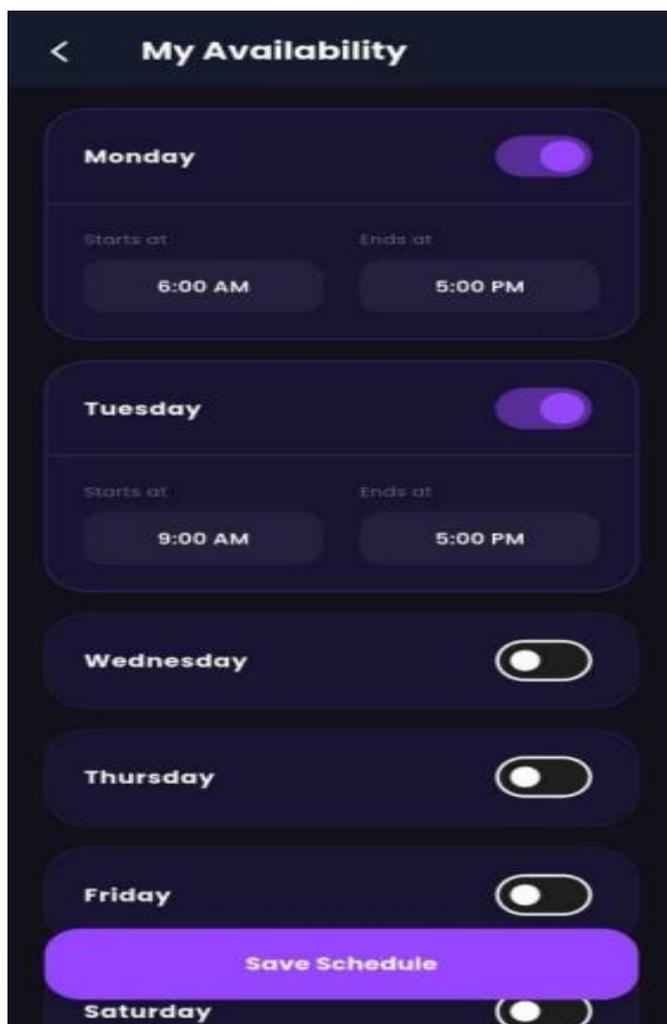


Fig 6 AI Smart Scheduling Interface

- *Real-Time Communication and Presence*

A robust real-time communication infrastructure was established to support immediate interaction between matched users. The system leverages Supabase Realtime to enable instant messaging, ensuring that messages are delivered without the need for manual page refreshes. Beyond basic text exchange, specific features for file sharing and captioning were added to support academic resource exchange. A presence tracking system was also implemented, allowing users to see the online status of their peers (e.g., "Online" or "Last seen..."). This feature is intended to increase engagement by indicating when a user is available for immediate collaboration.

- *Skill Credit Economy and Community Requests*

To incentivize user participation, a "Skill Credit" economy was introduced. Credits are awarded for daily logins and for successfully completing skill exchanges. These credits can then be tracked via a generic wallet interface and later converted to cash, encouraging sustained usage of the platform. A "Community Request Board" was also created to serve as a public forum for skill needs that are not immediately met by direct matchmaking. Users are able to post requests which are visible to the entire community, allowing for broader support. Advanced filtering options were implemented to allow users to sort these requests based on relevance or category.



Fig 7 Custom Matchmaking Interface

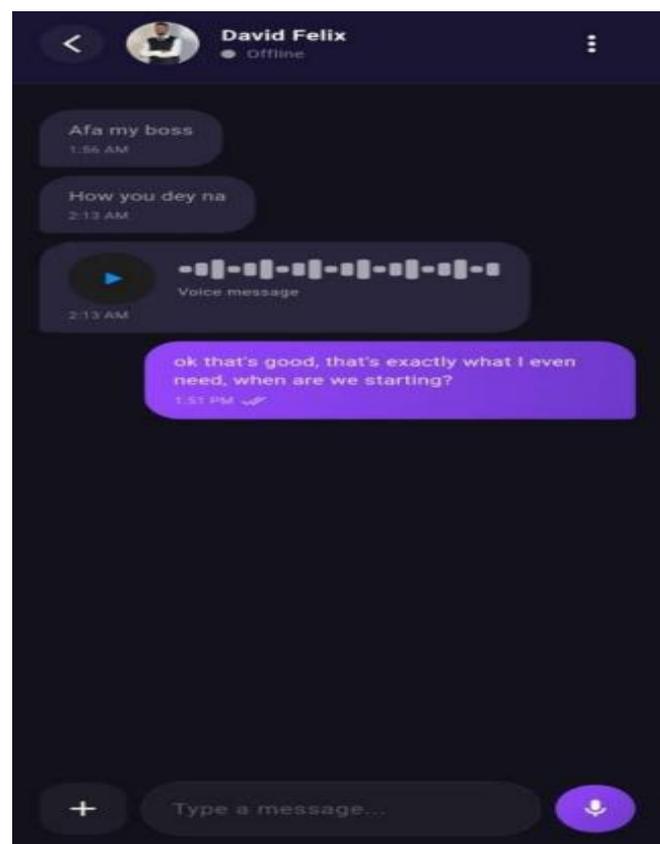


Fig 8 Real-Time Communication Interface

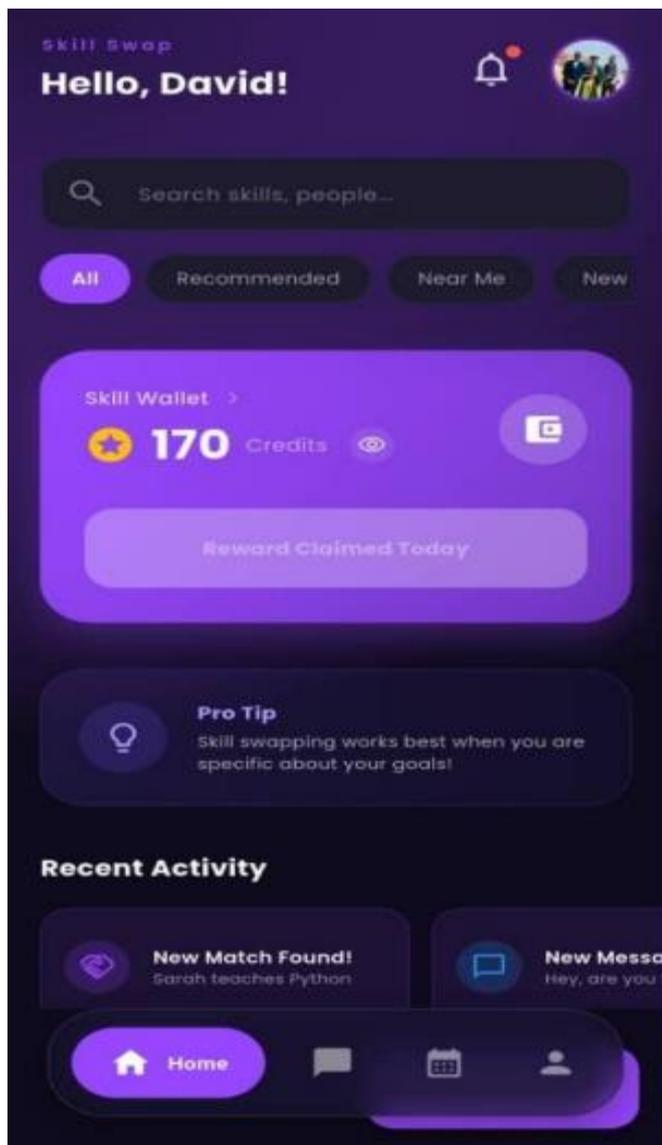


Fig 9 User Skill Credit Interface

## V. CONCLUSION AND FUTURE WORK

The SkillSwap platform demonstrates that peer-to-peer learning can effectively democratize access to practical education while fostering collaborative communities within academic institutions. As universities increasingly emphasize graduate employability, such platforms offer scalable solutions for skill development that complement traditional curricula without requiring significant institutional investment. The success of this mobile-first, community-driven approach suggests that future educational technology development should prioritize accessibility, cultural relevance, and peer collaboration over traditional instructor-centric models, particularly in resource-constrained environments where commercial alternatives remain prohibitively expensive.

This work successfully addresses critical gaps in educational technology accessibility through several key contributions by proposing a novel matching algorithm which uses a bidirectional skill matching approach, achieving 80-95% accuracy while ensuring mutual benefit for all participants, developed a mobile-first design, a cross-

platform Flutter implementation that helps to optimize accessibility for developing country contexts where mobile devices predominate. User acceptance testing confirms peer learning theory effectiveness in digital environments, with 78% of participants willing to use the platform for actual skill exchange, and the Cost-Effective Architecture of the Firebase-based implementation eliminates traditional server costs while providing enterprise-grade scalability and reliability. In conclusion, the literature establishes a strong theoretical and empirical foundation for mobile-based peer-to-peer digital skills exchange platforms in higher education. The convergence of social learning theories, ubiquitous mobile technology access, and the pressing need for continuous digital competency development creates a compelling rationale for such platforms. However, successful implementation requires careful attention to platform design principles that balance structure with flexibility, foster authentic community development, and align with established digital literacy frameworks. Future research should examine long-term sustainability factors, cross-cultural implementation variations, and mechanisms for ensuring equitable access and participation among diverse student populations. For future research directions, the study proposes AI-Powered Recommendations, which involve machine learning integration, to improve matching accuracy and personalize user experiences based on learning patterns and success indicators, and a Cross-Cultural Adaptation for Multi-language support and cultural contextualization could extend platform applicability across diverse educational environments.

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