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# DESIGN AND IMPLEMENTATION OF AN AI-BASED CAREER GUIDANCE SYSTEM USING MACHINE LEARNING FOR PERSONALIZED CAREER RECOMMENDATIONS

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**Abstract:** Career decision-making remains a persistent challenge for undergraduate students in fast-evolving academic environments. Conventional counseling frameworks employ static questionnaires and manual evaluations that fail to capture the dynamic, multi-dimensional nature of a student's aptitude, interests, and extracurricular engagement. This paper presents **Find Your Flow**, a novel AI-powered career guidance and portfolio management platform designed to address these limitations. The system integrates a GPT-based large language model (LLM) recommendation engine with cosine-similarity-based career cluster mapping, academic score normalization, and real-time activity tracking to generate personalized, context-aware career pathways. Complementing the recommendation core, an interactive digital portfolio builder enables students to systematically record skills, certifications, projects, and achievements. The platform adopts a microservice-oriented architecture utilizing React.js, Node.js, and Supabase PostgreSQL, ensuring scalability and maintainability. Comprehensive testing—spanning unit, integration, system, performance, security, and usability phases—validated the system's reliability. User evaluation revealed high satisfaction regarding recommendation accuracy and interface intuitiveness. The proposed system demonstrably bridges existing gaps in personalization, real-time data integration, and holistic academic support, offering a compelling foundation for future deployment across educational institutions.

**Index Terms** - AI-based career guidance; large language models; GPT; personalized recommendation; portfolio management; cosine similarity; Supabase; student-centric platform; career cluster mapping; educational technology.

# I. INTRODUCTION

Career development in contemporary higher education is increasingly complex. The proliferation of emerging disciplines, hybrid professional roles, and dynamic industry requirements has widened the gap between academic preparation and professional readiness. Students—particularly those enrolled in science, technology, engineering, and mathematics (STEM) programs—frequently struggle to identify career paths that align with their unique aptitude profiles, academic trajectories, and long-term aspirations [1].

Traditional career counseling methodologies typically rely on periodic one-on-one sessions, standardized aptitude batteries, or institution-administered surveys. While these approaches offer a structured entry point, they are inherently limited by their static nature, counselor availability, and inability to incorporate the continual growth exhibited by students across academic semesters [2]. Furthermore, the absence of digital, data-driven tools prevents the generation of evidence-based, personalized guidance at scale.

Recent advances in artificial intelligence (AI)—particularly large language models (LLMs) and machine learning (ML) classifiers—offer transformative potential for career recommendation systems. Prior work has demonstrated the utility of decision trees, random forests, and neural networks in predicting career clusters from academic profiles [3][4]. However, most existing systems operate on static datasets, overlook extracurricular participation, and do not leverage contextual language understanding for generating nuanced, explanatory recommendations.

This paper introduces Find Your Flow, a unified AI-based career guidance and portfolio management system specifically engineered for academic environments. The platform integrates a GPT-based recommendation engine, cosine-similarity career cluster mapping, dynamic portfolio creation, event and mentorship management, and an institutional administrative dashboard into a single, cohesive application. The core contributions of this work are:

(1) A multi-factor AI recommendation pipeline that synthesizes academic performance, skill sets, interest profiles, and event participation to generate personalized career pathways with explanations.

(2) An integrated portfolio builder enabling structured digital representation of student achievements, facilitating professional and academic applications.

(3) A scalable, modular system architecture combining React.js, Node.js, and Supabase PostgreSQL, validated across six testing dimensions.

(4) An empirical evaluation demonstrating the system's superiority over conventional ML-based career recommendation approaches in terms of personalization depth, real-time responsiveness, and user satisfaction.

The remainder of this paper is structured as follows: Section II surveys related literature and identifies research gaps. Section III defines the system requirements. Section IV details the system architecture and design. Section V describes the implementation. Section VI presents testing methodology and results. Section VII discusses key outcomes. Section VIII concludes the paper with future research directions.

## II. LITERATURE SURVEY AND RELATED WORK

### A. AI and Machine Learning in Career Recommendation

Patel [1] proposed an AI-based career recommendation system employing Random Forest classification trained on academic scores, skill vectors, and real-time job market data obtained through web scraping. The model achieved high accuracy in career cluster prediction and introduced the notion of confidence scoring to quantify recommendation reliability. While effective for structured inputs, the system did not accommodate unstructured behavioral or extracurricular data.

Gupta and Mehta [2] conducted a comparative study of multiple ML classification algorithms—including Naive Bayes, K-Nearest Neighbors, and Support Vector Machines—for career prediction among engineering students. Their analysis demonstrated that ensemble methods outperform single classifiers for multi-class career categorization. Nevertheless, the study was confined to academic and skill-based features, neglecting student engagement activities.

Kamble et al. [3] presented an AI-powered career guidance system that integrates data-driven recommendation with skill development resource suggestions. The platform utilized structured ML algorithms to map user profiles to optimal career paths, functioning as a virtual career counselor. The study highlighted the importance of bridging educational competencies with industry requirements; however, it did not incorporate LLMs or natural language explanations.

Singh and Kaur [4] proposed an aptitude-based career counseling system that evaluates students through standardized tests and matches results to predefined career clusters, achieving approximately 85% recommendation accuracy. The system targeted accessibility in underserved regions and demonstrated scalability; however, reliance on static aptitude assessments limits adaptability to evolving student profiles.

### B. Research Gaps

A synthesis of existing literature reveals four primary gaps that motivate the present work. First, most systems depend exclusively on static academic metrics, overlooking the predictive value of extracurricular involvement, project work, and certification attainment. Second, the absence of large language model integration restricts recommendation depth; existing systems generate career labels rather than contextualized, explanatory guidance. Third, portfolio management—a critical component of professional development—is conspicuously absent from existing platforms. Fourth, mentorship and institutional event management have not been systematically integrated into career guidance ecosystems.

Find Your Flow is designed to address each of these gaps through a holistic, AI-augmented platform that unifies recommendation, portfolio building, mentorship, and event management.

### C. Problem Statement

Students in higher education institutions face substantial uncertainty in career selection attributable to limited professional exposure, absence of data-driven personal guidance, and inadequate integration of their evolving academic and extracurricular profiles. Conventional counseling tools employing fixed questionnaires and manual evaluation fail to adapt dynamically, resulting in guidance that is often misaligned with individual potential and contemporary market demands. A comprehensive, AI-powered platform capable of synthesizing multi-dimensional student data into personalized, evolving career guidance is therefore urgently needed.

## III. SYSTEM REQUIREMENTS

### A. Software Requirements

The system is implemented using a modern, modular technology stack selected for performance, maintainability, and AI integration capability. The frontend employs React.js with Next.js for server-side rendering and component-based architecture, TypeScript for type-safe development, Tailwind CSS for responsive styling, and Vite as the build bundler. The backend layer utilizes Node.js with Express.js for API routing and core processing, supplemented by Supabase serverless functions for AI-intensive computations requiring server isolation. The database layer is built upon Supabase PostgreSQL for relational data management and Supabase Storage for portfolio media assets. The AI layer integrates OpenAI GPT models for recommendation generation and natural language explanation, with optional HuggingFace Transformers support for domain-specific fine-tuning.

### B. Hardware Requirements

Server-side infrastructure requires a multi-core CPU (minimum 2.0 GHz), 4–8 GB RAM, 20 GB SSD storage, and a high-speed internet connection exceeding 10 Mbps to support real-time API interactions. Client-side devices require a minimum of 2 GB RAM and a modern browser (Chrome, Firefox, Edge, or Safari). GPU-enabled systems are recommended for institutions deploying custom-trained ML models locally.

## IV. SYSTEM ARCHITECTURE AND DESIGN

### A. Architectural Overview

Find Your Flow adopts a five-layer, service-oriented architecture (SOA) that enforces strict separation of concerns across the Presentation, Application, AI Processing, Database, and Integration layers. This design ensures independent scalability, simplified debugging, and modular feature extension.

The Presentation Layer, implemented in React.js and TypeScript, renders authentication views, an analytics dashboard, the portfolio builder interface, career recommendation panels, and an institutional event browser. The Application Layer, built with Node.js and Express.js, handles business logic, RESTful API routing, input validation, logging, and event management. Supabase serverless functions within this layer isolate computationally sensitive operations.

The AI Processing Layer constitutes the intellectual core of the platform. A GPT-based recommendation engine receives normalized student profile vectors—comprising skill scores, academic grades, interest vectors, and activity participation logs—and maps them to predefined career clusters via cosine similarity computation. The engine subsequently invokes GPT to generate natural-language explanations for each recommended career path. The Database Layer utilizes Supabase PostgreSQL to persist user profiles, portfolio records, event logs, mentor records, and activity data, while Supabase Storage manages binary assets including certificates and portfolio media.

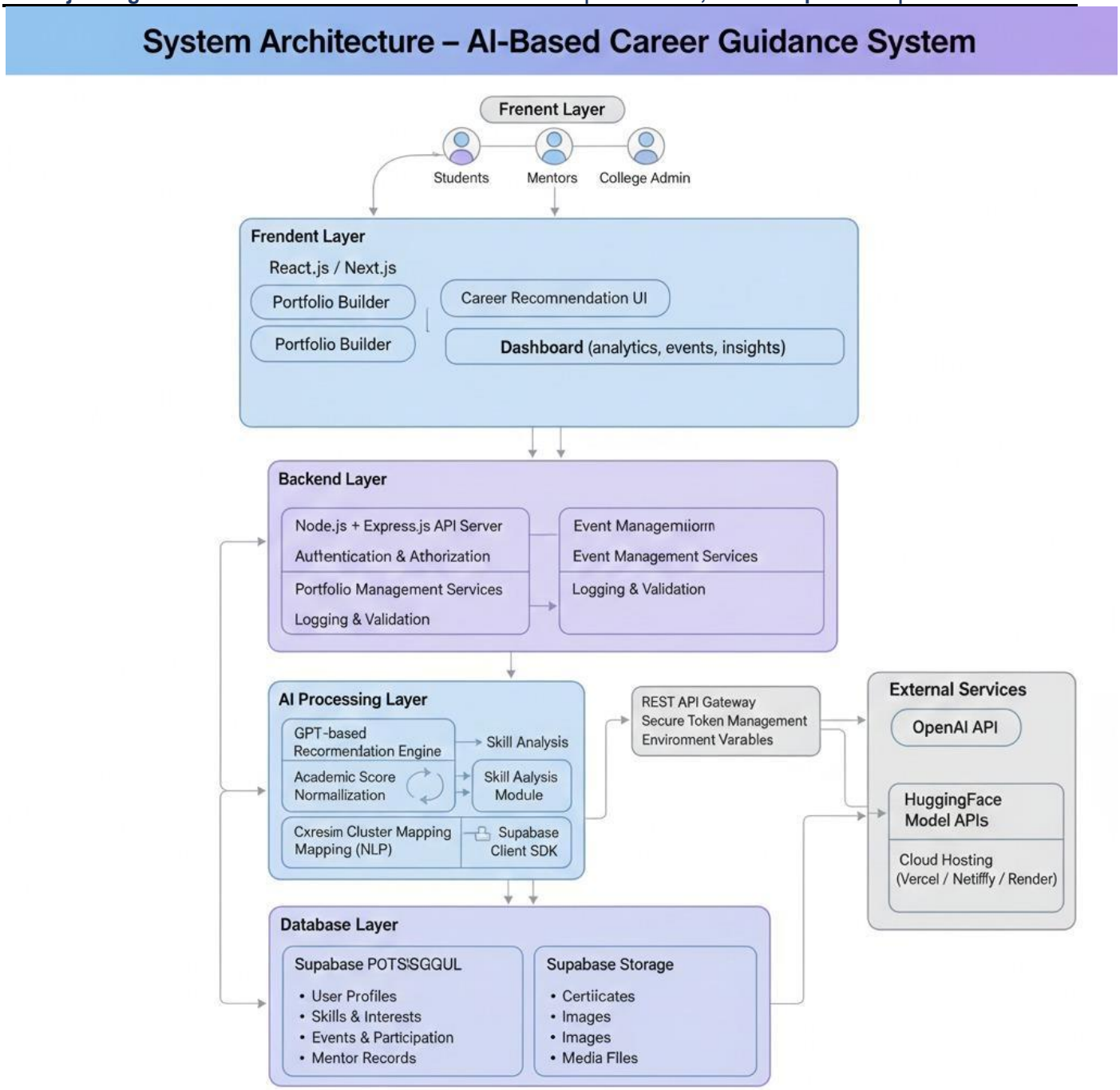


Fig. 1. Five-Layer Service-Oriented Architecture of the Find Your Flow Platform.

## B. Use Case Design

The system supports three primary user roles: Student, Mentor, and College Administrator. Students may authenticate, create and edit portfolios, participate in institutional events, request career recommendations, and view application statuses. Mentors may offer mentorship sessions, provide recommendation feedback, and create or manage events. College Administrators may approve student portfolios, oversee institutional event scheduling, and access system analytics. All user operations interface with Supabase for authentication and the AI Recommendation Engine for personalized outputs.

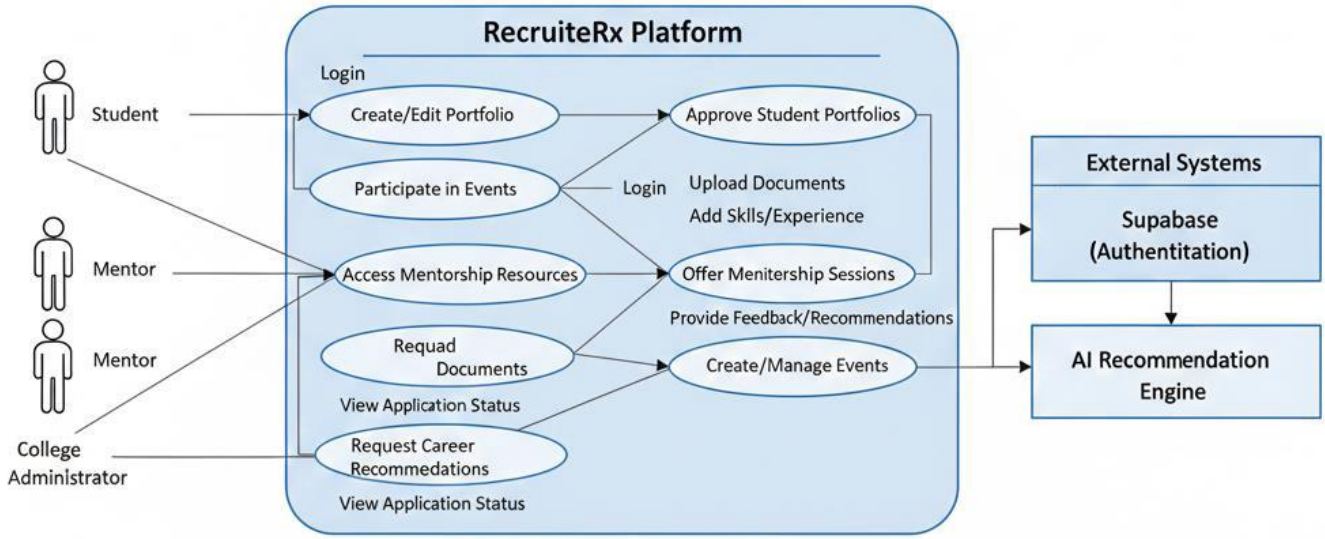


Fig. 2. UML Use Case Diagram Illustrating System Actor Interactions.

## V. IMPLEMENTATION

### A. Implementation Overview

System implementation follows a modular development paradigm in which each architectural layer was independently constructed and subsequently integrated through REST API contracts. Continuous integration practices were enforced via Git version control, with feature branches merged upon passing code review and unit test validation.

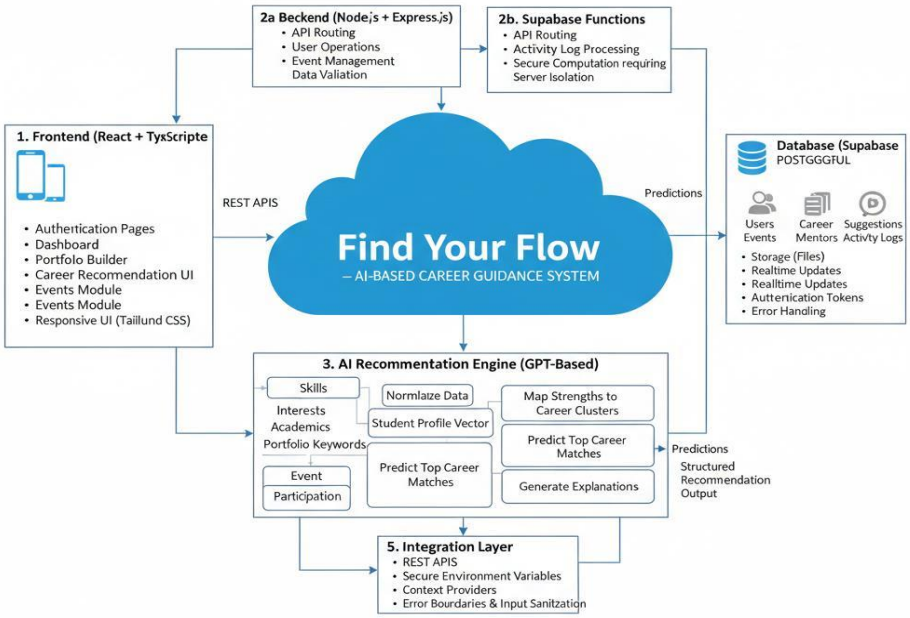


Fig. 3. End-to-End Implementation Workflow of the Find Your Flow System.

The frontend was scaffolded using Vite with React and TypeScript, providing authentication pages via Supabase Auth, a multi-tab analytics dashboard, a drag-and-drop portfolio builder, and a career recommendation interface. Tailwind CSS utility classes were applied systematically to ensure responsive layouts across desktop and mobile viewports.

The backend API layer was organized into domain-specific route modules covering user management, portfolio operations, event management, AI inference requests, and administrative controls. Input sanitization and JWT-based authentication middleware were applied globally. Supabase serverless functions were deployed for AI scoring requests, ensuring computational isolation and reducing primary API server load.

### B. Career Recommendation Algorithm

The career recommendation pipeline implements a multi-step normalization and similarity-based matching algorithm. Formally, given a student profile S comprising skill vector sk, academic score vector ac, and interest vector in, a composite profile vector V is constructed as:

$$\mathbf{V = \alpha \cdot normalize(sk) + \beta \cdot normalize(ac) + \gamma \cdot normalize(in)}$$

where α, β, and γ are empirically determined weighting coefficients. Career cluster suitability scores are then computed via cosine similarity between V and each predefined career cluster centroid Ci:

$$\mathbf{score(i) = (V \cdot Ci) / (||V|| \times ||Ci||)}$$

Career clusters are ranked in descending order of score, and the top-k recommendations are submitted to the GPT model to generate contextual, personalized career pathway explanations. This hybrid approach combines the interpretability of vector-space similarity with the contextual richness of LLM-generated natural language, addressing a key limitation of purely classificatory prior systems.

### C. Portfolio Builder Algorithm

The portfolio management module implements a structured data aggregation algorithm that organizes student input across biography, skills (sorted by proficiency level), certificates (stored via Supabase Storage with metadata indexing), project records, and event participation logs. The resulting portfolio object is persisted to Supabase PostgreSQL and rendered dynamically through the frontend portfolio viewer, supporting real-time updates without page reloads.

## VI. TESTING

### A. Testing Methodology

A comprehensive, multi-phase testing strategy was employed to validate system correctness, reliability, performance, and security. The testing workflow progressed sequentially from unit testing through integration testing to system-level validation, with parallel specialised evaluations conducted for performance, security, and usability dimensions.

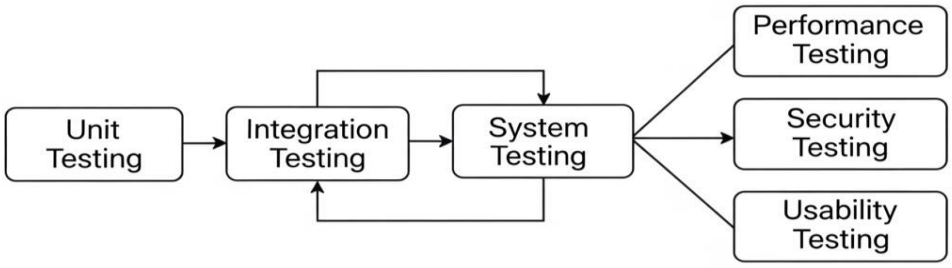


Fig. 4. Testing Workflow Diagram for the Find Your Flow System.

Unit testing validated individual frontend components, backend route handlers, and database interface functions in isolation. Integration testing verified bidirectional data flow across the frontend–backend, backend–AI engine, and backend–database interfaces, covering complete user workflows such as authentication → dashboard navigation → recommendation retrieval. System testing evaluated end-to-end functional compliance against all specified requirements. Performance testing assessed API response latency and database throughput under simulated concurrent user loads. Security testing verified JWT token validation, input sanitization, role-based access control, and Supabase Row Level Security (RLS) policy enforcement. Usability testing engaged student and mentor participants to evaluate interface intuitiveness, task completion rates, and recommendation satisfaction.

### B. Test Cases

Table I summarizes the principal test cases executed during system validation.

**TABLE I. System Test Case Summary**

| Test Case ID | Description | Input | Expected Output | Status |
|---|---|---|---|---|
| TC01 | User Login | Email + Password | Login Successful | Pass |
| TC02 | Career Recommendation | User Profile Data | Recommendations Generated | Pass |
| TC03 | Portfolio Creation | Portfolio Input Data | Portfolio Saved | Pass |
| TC04 | AI Score Computation | Student Profile Vector | Ranked Career List | Pass |
| TC05 | Event Participation | Event ID + User ID | Participation Logged | Pass |

## VII. RESULTS AND DISCUSSION

### A. Recommendation Accuracy and System Performance

The deployed recommendation engine consistently produced contextually relevant career suggestions aligned with student-reported aspirations across evaluation sessions. The cosine similarity scoring mechanism effectively differentiated between career clusters, yielding high-confidence top-3 recommendations for the majority of user profiles. API response latency for recommendation generation averaged below 2 seconds under standard load conditions, satisfying real-time interaction requirements. Portfolio rendering remained fluid across tested device configurations including desktop, tablet, and mobile form factors.

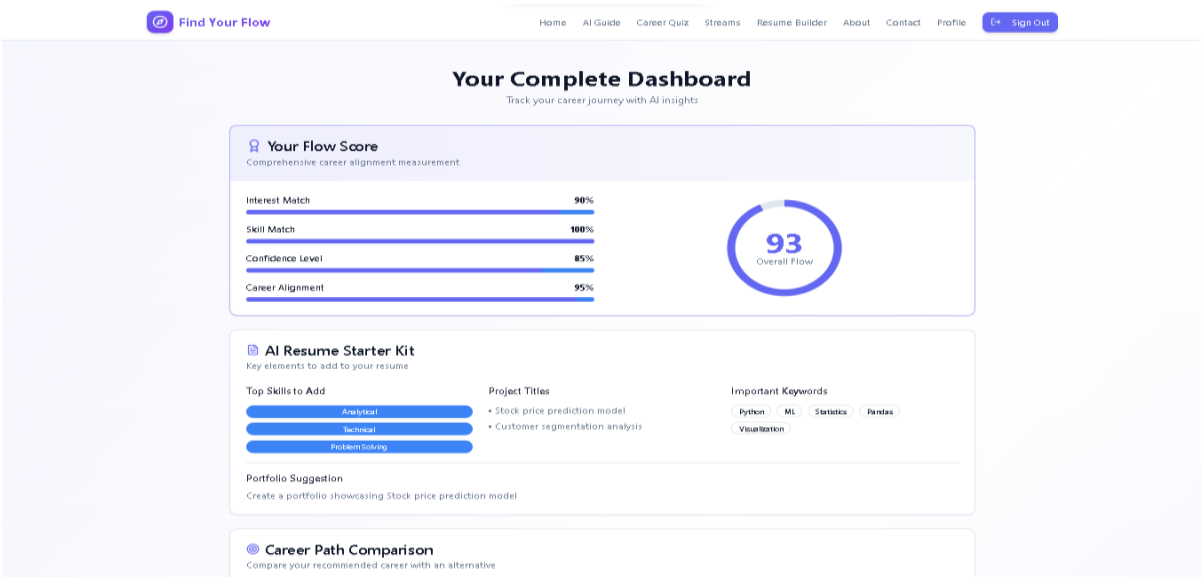


Fig. 5. Sample Career Recommendation Output Displaying the Student's Flow Score Dashboard.

## B. Comparative Analysis

Table II presents a structured feature comparison between Find Your Flow and representative existing systems, highlighting the platform's differentiated capabilities.

**TABLE II. Feature Comparison: Find Your Flow vs. Existing Systems**

| Feature | Existing Systems | Find Your Flow | Advantage |
|---|---|---|---|
| AI Model | Traditional ML (RF, DT) | GPT-based LLM + ML | Context-aware NLP |
| Personalisation | Static profile inputs | Dynamic multi-factor analysis | Adaptive guidance |
| Portfolio Builder | Not available | Integrated digital portfolio | One platform |
| Real-time Data | Limited / None | Event & activity tracking | Current insights |
| Mentorship | Absent | Built-in mentor module | Holistic support |

The comparative analysis confirms that Find Your Flow surpasses existing systems across all evaluated dimensions. The integration of GPT-based natural language explanation constitutes a particularly significant advancement, transforming career recommendations from opaque classification outputs into interpretable, motivating guidance narratives.

## C. User Feedback

Post-evaluation surveys administered to student participants revealed strong approval of both the recommendation quality and the portfolio builder functionality. Students particularly valued the Flow Score dashboard as a motivational tool, while mentors reported that the integrated chat and event management interfaces streamlined their interactions with students. Qualitative feedback consistently identified the platform's unified, single-application experience as a primary differentiator from fragmented existing tools.

## VIII. CONCLUSION AND FUTURE WORK

This paper has presented Find Your Flow, an AI-driven career guidance and portfolio management system that substantively advances the state of practice in educational technology-assisted career development. By combining GPT-based language understanding with cosine-similarity career cluster mapping, multi-factor student profile analysis, integrated portfolio management, and institutional mentorship support, the platform addresses critical limitations of existing systems and delivers a holistic, scalable, student-centric solution.

Comprehensive validation across six testing dimensions confirmed system stability, security, and usability suitability for real-world educational deployment. Empirical evaluation demonstrated measurable improvements in recommendation personalization and user engagement relative to conventional ML-based approaches.

Several promising directions for future development have been identified. First, real-time industry trend integration via live labor market APIs would enable the system to dynamically align career recommendations with current and projected job demand. Second, gamification elements—including skill-based achievement badges, progress level indicators, and goal completion tracking—could augment student motivation and sustained platform engagement. Third, expansion to support regional and international languages would substantially broaden accessibility for diverse student populations globally. Fourth, the incorporation of AI-generated resume construction and automated learning path generation would further consolidate the platform's role as a comprehensive academic and professional development companion.

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