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# Abstract

Choosing a career is often challenging for students because traditional guidance methods focus mainly on academic performance and overlook other important factors such as personality, interests, and experiences. This limitation can lead to career choices that do not fully align with students’ strengths or goals. This study introduces *CareerCompass*, a career path recommender system designed to provide personalized career suggestions that integrate both academic and non-academic attributes. The system was developed using a Laravel backend connected to a FastAPI machine learning service. It applies the **LightGBM algorithm**, trained on both synthetic datasets and real-world data collected from surveys and online career platforms. CareerCompass evaluates academic records, RIASEC personality traits, interests, skills, and extracurricular activities to generate recommendations. The system also provides tailored career options, career roadmaps, interactive quizzes, motivational success stories, and a community forum for peer and mentor interaction. In addition, counselors and educators can use an analytics dashboard to identify trends and provide better student support. The findings suggest that CareerCompass can serve as a practical, user-friendly, and scalable tool for career guidance. By combining machine learning with modern web technologies, the platform offers a holistic approach that supports students in making informed and confident career decisions.

# Introduction

Career selection is a critical milestone for young people, often marked by confusion due to the evolving job market and limited guidance. Emerging fields like artificial intelligence, renewable energy, and digital marketing demand diverse skills, yet traditional counseling emphasizes grades, overlooking personal interests and strengths. Online resources, while abundant, often provide generic or conflicting advice, leaving students overwhelmed. CareerCompass addresses these challenges through a web-based platform that combines Laravel’s robust backend with a FastAPI-driven machine learning service using LightGBM. By analyzing academic performance, RIASEC personality traits, interests, skills, and experiences, it offers tailored career suggestions, practical roadmaps, and motivational content. The platform aims to empower students, particularly those feeling uncertain, to make informed career choices with confidence.

## 1.1 Background Studies

The job market is rapidly evolving, with growing demand for skills in data science, healthcare, and sustainable technologies. The World Economic Forum (2023) projects that 60% of jobs by 2030 will require skills like critical thinking and digital literacy, yet personalized career guidance remains scarce. Traditional counseling often directs students toward conventional fields based on academic performance, sidelining traits like creativity or leadership. Online tools, such as MyNextMove.org, provide basic career suggestions but lack depth in analyzing personal attributes or offering actionable steps. For underrepresented groups, the absence of relatable role models further complicates career planning. CareerCompass leverages machine learning and user-centric features to deliver comprehensive, reliable guidance.

## 1.2 Problem Statement

Students face multiple obstacles in career planning. Traditional counseling often overemphasizes academic performance, recommending fields like engineering for high math scores while ignoring interests in areas like art or social work. This can lead to career dissatisfaction. Online career advice is frequently generic, outdated, or contradictory, making it difficult to find trustworthy guidance. Existing tools often rely on simplistic questionnaires, failing to account for a student’s unique skills, personality, or experiences. Additionally, students from marginalized communities may lack relatable role models, making fields like technology seem unattainable. These challenges result in uninformed career decisions, impacting long-term satisfaction and success. CareerCompass aims to provide a personalized, practical, and inspiring solution to these issues.

## 1.3 Objective

CareerCompass seeks to create a user-friendly platform to guide students toward suitable careers. Specific goals include

* Develop a LightGBM model achieving ≥80% accuracy in recommending careers based on grades, RIASEC traits, interests, skills, and experiences.
* Provide interactive quizzes for skill development with feedback.
* Offer a community forum for peer and mentor interaction.
* Include diverse success stories to inspire users, particularly from underrepresented groups.
* Create an analytics dashboard for counselors to track trends.
* Ensure accessibility and responsiveness across devices within a three-month timeline.

## 1.4 Solutions

CareerCompass addresses the challenges of career planning with a mix of technology and user-focused features. It starts with an engaging questionnaire that collects data on a user’s grades, personality, interests, skills, and experiences, making it feel fun rather than tedious. A machine learning model, built with Python and trained on synthetic profiles and real-world data from Kaggle and surveys, suggests 3 careers with clear explanations, like “You’re a good fit for graphic design because of your creativity and art skills.” The platform offers career roadmaps with practical steps, such as links to free courses on Khan Academy or YouTube tutorials. Interactive quizzes help users practice skills like communication, with instant feedback to improve. A community forum lets users connect with peers and mentors for advice, while AI-generated success stories highlight diverse professionals to inspire confidence. Users can download PDF reports of their career plans to share with advisors.

# Literature Review

Career planning is a complex process, often hindered by limited guidance and outdated tools. This review synthesizes findings from 15 open-access research papers, books, and reports to explore career guidance systems, machine learning applications, the RIASEC model, and the role of motivation and technology in career planning. It identifies gaps in existing solutions and positions CareerCompass as a comprehensive, personalized platform.

## 2.1 Traditional Career Guidance and Its Limitations

Traditional career counseling often focuses on academic performance[. Kulcsár, V., Dobrean, A. and Gati, I. (2020)](#Rf_Kulcsar2020) noting that 65% of counselors focus on grades, steering students toward conventional fields regardless of their interests. This can lead to job dissatisfaction, with [Hooley et al. (2021)](#Rf_Hooley2024) noting that 35% of young professionals feel mismatched in their careers. A book by Savickas (2020) on career construction theory stresses that interests and personality are as crucial as grades for long-term job satisfaction. [Wm.edu. (2025)](#Rf_Wmedu2025) also found that counselors often overlook traits like creativity or teamwork, which are vital for fields like design or management. These studies show the need for guidance that considers the whole person.

## 2.2 Online Career Tools and Their Shortcomings

Online career quizzes, like those on O\*NET’s [My Next Move (2019)](#Rf_MyNextMove2019), are user-friendly but often oversimplified. [Hirschi, A. and Läge, D. (2008)](#Rf_Hirschi2008) found that these tools rely on basic questions, like “Do you enjoy helping others?” leading to generic suggestions such as “teacher” or “nurse.” They rarely analyze skills or experiences, limiting their usefulness. [Redekopp, D., Hopkins, S. and Hiebert, B. (2013)](#Rf_Redekopp2013).  noted that students feel overwhelmed by unverified online advice on platforms like social media, which is often outdated. A report by [UNESCO (2024)](#Rf_UNESCO2024) confirms that many digital career tools lack personalization, leaving users confused about reliable options.

## 2.3 Machine Learning in Career Recommendations

Machine learning (ML) is improving career guidance by analyzing diverse data. [Geethanjana (2025)](#Rf_Geethanjana2025) achieved 70% accuracy using Random Forest but lacked real-world data. [Nguyen (2023)](#Rf_Nguyen2023) explored XGBoost to predict employability, noting its strength with incomplete datasets but highlighting the need for actionable steps. A review by [Biau (2015)](#Rf_Biau2015) highlight Random Forest’s strength in pattern recognition, but LightGBM was chosen for CareerCompass due to its efficiency with high-dimensional data, ensuring accurate and scalable recommendations.

## 2.4 RIASEC Model for Personality-Based Guidance

The RIASEC model categorizes personalities into Realistic, Investigative, Artistic, Social, Enterprising, and Conventional types. [Hoff (2020)](#Rf_Hoff2020). Holland’s RIASEC model has consistently demonstrated value in aligning people with compatible career paths. A comprehensive meta-analysis revealed that vocational interest–environment fit significantly predicts job satisfaction (ρ ≈ 0.19), supporting the idea that Investigative types often thrive in research-oriented roles [Silva et al (2020)](#Rf_Silva2020) introduced the JPLink model, which uses machine learning and O\*NET data to automatically label job postings with RIASEC types—improving match accuracy and supporting scalable career recommendation systems. [Rahman, Muh.F., Alamsyah, Muh.N. and Firdaus, H. (2025)](#Rf_RahmanMuhF2025) found that using RIASEC-based assessments—coupled with reflective guidance—helped participants develop clearer career insights and greater confidence in planning their futures. Given these findings, CareerCompass leverages RIASEC in tandem with skills, interests, and academic data to offer more precise and developmentally appropriate recommendations.

## 2.5 Importance of Role Models

Relatable role models boost motivation, especially for underrepresented groups. [Gladstone, J.R. and Cimpian, A. (2021)](#Rf_Gladstone2021). found that similar and attainable role models inspire students. [Ronnie, S., Santos (2024)](#Rf_RonnieSantos2024) noted that students without role models are less likely to persist in fields like technology. CareerCompass includes AI-generated success stories to provide diverse, motivational narratives.

## 2.6 Actionable Guidance and Skill Development

Effective career tools provide clear steps. [Warrner, J. (n.d.)](#Rf_WarrnerJND)  
For example, mentees in structured mentorship programs report gains in career planning, confidence, and academic performance when provided with specific, milestone-based guidance [Miske, S. and Sogunro, O. (2024)](#Rf_MiskeSandSogunro2024). CareerCompass builds on this by offering roadmaps like “learn JavaScript on Coursera” and embedded quizzes to help users develop relevant skills.

## 2.7 Community and Mentorship

Community engagement and mentorship are vital for students’ confidence and decision-making. A longitudinal review found that formal mentorship improves career planning and transitions, especially for underrepresented groups and women in higher education [Nabi, G., Walmsley, A., Mir, M. and Osman, S. (2024)](#Rf_NabiGWalmsley2024) Evaluations of peer mentorship and student–professional forums have shown improvements in self-efficacy, networking skills, and career preparedness among mentees [Graham, M., Wayne (2022)](#Rf_GrahamMWayne2022) CareerCompass incorporates a **moderated forum and mentorship network**, pairing users with verified professionals to ensure guidance is accurate and supportive.

## 2.8 Accessibility and Usability

Usability and accessibility are crucial for reaching diverse users. While exact statistics on digital career tool accessibility are scarce, education frameworks emphasize the need for inclusive design that works across devices and meets accessibility standards [Ijnrd.org. (2016)](#Rf_Ijnrdorg2016)   
Studies confirm that mobile-friendly, intuitive interfaces significantly boost engagement and usability—student retention and comfort increase when design is responsive and simple [Warrner, J. (n.d.)](#Rf_WarrnerJND)*.* CareerCompass adheres to **WCAG 2.1 standards**, features clean navigation, and is optimized for mobile devices to maximize inclusivity and engagement.

## 2.9 CareerCompass’ Contribution

By integrating well-supported design elements—personalized role-model narratives, step-by-step guidance, moderated mentorship, and accessible interfaces—CareerCompass offers a comprehensive platform that addresses current gaps.

* ML-based career matching (LightGBM) is combined with actionable next steps, enhancing usability.
* Role-model storytelling encourages inspiration across diverse student backgrounds.
* A moderated mentorship community ensures accurate, tailored support.
* Accessibility-first design ensures inclusivity across devices and users with varying abilities.

# Planning

This section outlines the development plan for CareerCompass, covering feasibility, risks, SWOT and PESTAL analyses, the Agile life cycle model, and a three-month timeline to deliver a functional platform.

## 3.1 Feasibility Report

The feasibility study evaluates whether CareerCompass can be successfully developed by one person in three months using available resources. The project is feasible for the following reasons:

### 3.1.1 Technical Feasibility

CareerCompass uses Laravel for the backend, MySQL for data storage, and Python with scikit-learn for machine learning. FastAPI connects the LightGBM model to the backend via REST APIs. The frontend, built with Bootstrap and Blade templates, ensures responsiveness. Synthetic data (1000 profiles via Faker) and real-world data (Kaggle, surveys) are accessible. Local deployment eliminates hosting concerns.

### 3.1.2 Operational Feasibility

The platform features an intuitive questionnaire with progress bars and adheres to WCAG 2.1 for accessibility. It supports multiple devices, and a user manual will guide students and counselors, ensuring ease of use.

### 3.1.3 Economic Feasibility

All tools (Laravel, MySQL, Python, FastAPI, Bootstrap, Chart.js, jsPDF) and data sources (Kaggle, Google Forms) are free. Local deployment incurs no server costs, making the project cost-effective.

### 3.1.4 Time Feasibility

The project is divided into six two-week sprints, each focusing on specific tasks like setting up the backend, training the machine learning model, or building the forum. Laravel’s built-in features, such as authentication and database management, reduce coding time. The machine learning model can be trained quickly using synthetic and real-world data. Testing will include unit tests (with Laravel), API tests (with Postman), and user testing with peers to ensure the platform works well.

## 3.2 Risk Assessment

Key risks and mitigation strategies include

* **Limited Model Accuracy**: Low data diversity may reduce accuracy. Mitigation includes using varied synthetic and real-world data, with model fine-tuning based on precision and recall.
* **Time Constraints**: The tight timeline risks incomplete features. An Agile approach with prioritized core features ensures progress.
* **User Interface Issues**: A confusing interface may deter users. Bootstrap and user testing ensure a clean, intuitive design.
* **Data Privacy Concerns**: Users may fear data exposure. Secure authentication (JWT) and encrypted local storage address this.

## 3.3 SWOT Analysis

The SWOT analysis examines the project’s strengths, weaknesses, opportunities, and threats to guide development.

### 3.3.1 Strengths

* Personalized recommendations using LightGBM and comprehensive data.
* Responsive, accessible design with Bootstrap.
* Free tools ensure cost-effectiveness.
* Features like roadmaps, quizzes, and forums enhance user engagement.

### 3.3.2 Weaknesses

* Limited real-world data may miss regional trends.
* Single-developer dependency risks delays.
* Local deployment limits scalability testing.

### 3.3.3 Opportunities

* Future partnerships with schools for richer data.
* Potential for a mobile app to expand reach.
* Scalability for online deployment to serve underserved areas.

### 3.3.4 Threats

* Competition from existing career tools.
* Technical bugs in the model or backend.
* Low user adoption if the platform seems complex.

## 3.4 PESTAL Analysis

The PESTAL analysis looks at external factors—Political, Economic, Social, Technological, Environmental, and Legal—that could affect CareerCompass.

### 3.4.1 Political

Government policies promoting education and career planning, such as STEM initiatives, support the need for tools like CareerCompass. However, there are no direct political barriers since the project is for academic purposes and runs locally.

### 3.4.2 Economic

The project is cost-effective, using free tools and data sources. Economic challenges, like limited access to technology for some students, are not a concern for local testing but could affect future online deployment.

### 3.4.3 Social

Young people, especially from diverse or underserved backgrounds, need relatable career guidance. CareerCompass addresses this by offering success stories and a community forum. Social trends, like increased interest in tech careers, align with the platform’s focus on fields like data science or web development.

### 3.4.4 Technological

Advances in machine learning (LightGBM) and web development (Laravel, FastAPI) make the project technically possible. Open-source tools and datasets (Kaggle, Faker) are readily available, supporting development.

### 3.4.5 Environmental

The project has no direct environmental impact, as it runs on a local computer. Future online hosting could consider energy-efficient servers to align with sustainability trends.

### 3.4.6 Legal

Since the project is for academic use and stores data locally, there are no legal concerns like GDPR compliance. However, user data privacy is ensured through secure authentication and encryption.

## 3.5 Life Cycle Model

### 3.5.1 Introduction

CareerCompass adopts an Agile SDLC, adapted from Scrum, to manage development within three months. Agile’s iterative approach suits the project’s solo developer and evolving requirements.

### 3.5.2 Methodology Description

Agile is an iterative and incremental approach to software development that prioritizes flexibility, customer value, and continuous improvement. As outlined in the Agile Manifesto, it values individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan. In practice, Agile breaks down the project into manageable units called sprints—short, time-boxed periods during which a usable increment of the product is developed.

### 3.5.3 Rationale for Selecting Agile

Traditional SDLC models like Waterfall follow a sequential, linear progression: requirements gathering, design, implementation, testing, and maintenance. While suitable for projects with fixed scopes and minimal changes, Waterfall can introduce inefficiencies in environments where requirements evolve or technical challenges emerge unexpectedly—common in machine learning-driven applications like CareerCompass.

Agile was chosen for its ability to mitigate these risks through short cycles that enable rapid feedback and adaptation. Key justifications include.

* **Adaptability to Solo Development**: As a single-developer project, Agile's flexibility allows for informal adaptations, such as daily self-reviews instead of team stand-ups, while maintaining momentum.
* **Handling Uncertainty**: Features like training the model on synthetic and real-world data may require iterations based on accuracy results, which Agile accommodates without derailing the timeline.
* **Alignment with Project Constraints**: The three-month duration and local deployment for academic purposes benefit from incremental deliverables, ensuring a functional platform is built progressively.
* **Promotion of Quality**: Regular testing and retrospectives reduce the likelihood of late-stage issues, such as integration bugs between FastAPI and Laravel.

This approach contrasts with Waterfall by fixing time and resources (e.g., two-week sprints) to control scope, rather than fixing scope to manage time and cost.

### 3.5.4 Implementation in the Project

The Agile implementation for CareerCompass follows a structured sprint lifecycle, tailored to solo development

* **Sprint Planning**: Tasks are selected per sprint (e.g., Sprint 1: Laravel setup, database design).
* **Development**: Execute tasks like model training or forum development.
* **Daily Reviews**: Assess progress and adjust priorities.
* **Sprint Review**: Validate features via testing.
* **Retrospective**: Reflect on challenges and improvements.

### 3.5.5 Benefits and Expected Outcomes

Agile ensures early issue detection, quality deliverables, and efficient resource use, delivering a robust platform within the timeline.

## 3.6 Time Plan

The CareerCompass project follows an Agile methodology with six two-week sprints over three months, ensuring iterative development and adaptability. A dynamic product backlog prioritizes features, allowing flexibility to reprioritize based on progress and feedback. Each sprint includes planning, development, review, and retrospective phases, tailored for a solo developer. Daily self-reviews track progress, and peer feedback is incorporated early to enhance usability. Tasks are distributed to balance workload, ensuring deliverable increments per sprint.

**Product Backlog (Initial)**

* Set up Laravel, MySQL, and FastAPI.
* Generate synthetic profiles.
* Collect real-world data (Kaggle, Google Forms).
* Design database schema.
* Implement user authentication (signup, login, password reset).
* Develop interactive questionnaire with progress tracking.
* Train LightGBM model and integrate with FastAPI.
* Create skill-building quizzes with feedback.
* Build community forum with moderation.
* Develop admin analytics dashboard with Chart.js.
* Generate 500 AI-driven success stories using GPT-2.
* Create career roadmap pages with resource links.
* Implement PDF report generation with jsPDF.
* Conduct unit, API, and user testing.
* Document setup, features, ML model, and user manual.
* Optimize performance and prepare deployment guide.

### 3.6.1 Weeks 1–2: Project Setup and Data Preparation

* **Tasks**
  + Initialize Laravel project, MySQL database, and FastAPI service.
  + Generate 1000 synthetic profiles using Python’s Faker library.
  + Collect Kaggle CareerVillage dataset and Google Forms survey data.
  + Design database schema for users, questionnaires, and content.
  + Document setup and schema: Create project wiki with setup guide and schema outline.
* **Sprint Goal**: Establish project foundation and initial dataset.
* **Deliverables**: Laravel project setup, MySQL database, 1000-profile dataset, schema design, initial wiki documentation (setup guide, schema).
* **Review & Retrospective**: Validate setup functionality; reflect on setup efficiency and data quality; adjust backlog if needed (e.g., prioritize additional data sources).

### 3.6.2 Weeks 3–4: Authentication and Questionnaire

* **Tasks**
  + Implement user authentication (signup, login, password reset) using Laravel’s JWT-auth.
  + Develop interactive questionnaire with form validation and progress bar.
  + Connect questionnaire to MySQL for response storage.
  + Conduct peer testing of questionnaire usability with 2–3 peers.
  + Document authentication and questionnaire: Update wiki with user flows, API endpoints, and validation logic.
* **Sprint Goal**: Deliver secure authentication and a user-friendly questionnaire.
* **Deliverables**: Functional login system, multi-step questionnaire with progress tracking, data storage integration, peer feedback report, updated wiki documentation.
* **Review & Retrospective**: Test authentication and questionnaire functionality; incorporate peer feedback; reflect on usability issues and adjust backlog (e.g., simplify questionnaire if needed).

### 3.6.3 Weeks 5–6: Machine Learning and API Integration

* **Tasks**
  + Train LightGBM model on synthetic and real-world data, targeting ≥80% accuracy.
  + Integrate FastAPI with Laravel via REST APIs for career predictions.
  + Test prediction functionality with sample inputs.
  + Document ML model and APIs: Update wiki with training process, API specifications, and test results.
* **Sprint Goal**: Deliver a functional ML model integrated with the backend.
* **Deliverables**: Trained LightGBM model, FastAPI-Laravel integration, career suggestion functionality, updated wiki documentation.
* **Review & Retrospective**: Evaluate model accuracy and API performance; reflect on training challenges (e.g., data quality); adjust backlog (e.g., add model fine-tuning if accuracy is low).

### 3.6.4 Weeks 7–8: Quizzes and Admin Dashboard

* **Tasks**
  + Develop skill-building quizzes with immediate feedback.
  + Build admin analytics dashboard using Chart.js for career trends.
  + Conduct peer testing of quizzes with 2–3 peers.
  + Document quizzes and dashboard: Update wiki with quiz logic and dashboard analytics details.
* **Sprint Goal**: Deliver interactive quizzes and an analytics dashboard.
* **Deliverables**: Functional quizzes with feedback, admin dashboard, peer feedback report, updated wiki documentation.
* **Review & Retrospective**: Test quiz engagement and dashboard usability; incorporate peer feedback; reflect on development challenges and adjust backlog (e.g., prioritize forum if quizzes are complete early).

### 3.6.5 Weeks 9–10: Forum, Success Stories, and Resources

* **Tasks**
  + Develop moderated community forum for peer and mentor interaction.
  + Generate 500 success stories using GPT-2.
  + Create career roadmap pages with links to free online courses (e.g., Coursera, Khan Academy).
  + Implement PDF report generation with jsPDF.
  + Document forum, stories, and resources: Update wiki with forum moderation rules, story generation process, and PDF logic.
* **Sprint Goal**: Deliver motivational and community features.
* **Deliverables**: Functional forum, success story library, roadmap pages, PDF report functionality, updated wiki documentation.
* **Review & Retrospective**: Test forum moderation and story engagement; reflect on feature integration; adjust backlog (e.g., prioritize bug fixes if needed).

### 3.6.6 Weeks 11–12: Testing and Finalization

* **Tasks**
  + Conduct comprehensive testing: unit tests (Laravel), API tests (Postman), and user testing with 5–10 sample users.
  + Optimize performance (e.g., add caching for faster API responses).
  + Finalize documentation: Consolidate wiki into user manual, technical documentation, and ML evaluation report.
  + Prepare deployment guide and project handover notes.
* **Sprint Goal**: Deliver a polished, fully tested platform with complete documentation.
* **Deliverables**: Finalized platform, user feedback report, complete documentation (user manual, technical docs, ML report, deployment guide).
* **Review & Retrospective**: Validate platform functionality; reflect on user feedback and optimization; finalize backlog closure.

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