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SKILLPATH AI: NEXT-GENERATION ADAPTIVE AI LEARNING ROADMAP PLATFORM

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Abstract: Self-directed learners in computer science and software engineering often face fragmented learning resources, rigid course schedules and limited personalized guidance. This paper presents SkillPath AI, an adaptive learning roadmap platform that converts a learner's target skill, proficiency level, available study time and career goals into a structured day-by-day learning plan. Powered by Groq's Tensor Streaming Processor (TSP) and Meta's Llama-3.3 70B Versatile model, the platform reports curriculum-generation latency below 2.5 seconds. Its modules include an algorithmic curriculum architect, an interactive daily focus tracker with learning streaks, a context-aware AI code tutor and a scenario-based diagnostic quiz runner. A dual-engine persistence layer uses Supabase PostgreSQL when cloud credentials are available and falls back to local SQLite3 otherwise. The project report records 24 functional test cases with a 100% pass rate, a 90.4% reduction in curriculum-generation latency and 5.1× higher token throughput compared with conventional cloud LLM endpoints. These figures represent the results reported for the implemented project.

Keywords: Adaptive Learning, Intelligent Tutoring Systems, Large Language Models, Groq TSP, Llama-3.3 70B, Curriculum Generation, AI Code Tutor.

I. INTRODUCTION

The software engineering landscape changes rapidly, requiring learners to understand modern frameworks, APIs, databases, cloud platforms and deployment practices. Online resources are abundant, but learners must assemble them into a coherent sequence. Static roadmaps provide broad topic relationships, while pre-recorded courses generally follow fixed schedules. Generic AI chat interfaces answer isolated questions but may not preserve learner progress or connect answers to a structured curriculum.

SkillPath AI addresses these limitations through a unified learning workspace. A learner specifies a target technical skill, current proficiency, duration, daily time budget, learning style and career objective. The platform generates daily tasks, links learning resources, tracks completion and provides contextual technical assistance. Its objective is to encourage active practice rather than passive consumption.

II. BACKGROUND AND RELATED WORK

Intelligent Tutoring Systems (ITS) have explored personalized instruction since early computer-assisted learning systems. Learning management systems and massive open online courses expanded access to educational content, but commonly retain largely predetermined course structures. Roadmap.sh provides role-based visual roadmaps; Coursera and Udemy provide structured courses; and LeetCode and HackerRank emphasize programming exercises rather than a complete personalized software-engineering learning journey.

Transformer-based language models have made it possible to generate explanations and learning material from natural-language specifications. However, unstructured chatbot responses do not automatically provide persistent learner state, daily milestones or diagnostic assessment. SkillPath AI combines model-generated content with curriculum persistence, progress tracking and assessment. Its design draws on research in Transformer models [1], language models [2], code-focused foundation models [3], intelligent tutoring [4] and retrieval practice [5].

III. PROPOSED SYSTEM AND METHODOLOGY

A. System Architecture

The platform follows a multi-tier architecture. The presentation tier uses HTML5, custom CSS3 and vanilla JavaScript. The application tier uses Python and Flask with an Application Factory pattern and modular Blueprints for authentication, dashboard, roadmap, tutor, quiz, projects and API operations. The AI tier uses Groq Cloud TSP with Llama-3.3 70B Versatile. A unified database adapter selects Supabase PostgreSQL when valid cloud credentials are configured and otherwise uses local SQLite3.

B. Curriculum Generation and Learning Workflow

The learner profile includes target skill, experience level, duration, daily time availability and career goal. The curriculum engine converts these inputs into multi-week modules and day-wise learning units containing topics, subtopics, time estimates, documentation references and practical tasks. The workflow proceeds through profile initialization, AI curriculum synthesis, interactive daily execution, context-aware mentorship and diagnostic mastery validation. Completed tasks update progress indicators and learning streak records.

C. Output Validation and Resilience

The AI service applies JSON extraction and sanitization before parsing model output. If the Groq API key is unavailable or a network failure occurs, a deterministic heuristic curriculum generator provides a fallback. This is intended to prevent malformed model output or temporary connectivity problems from interrupting the learner workflow.

IV. IMPLEMENTATION AND EVALUATION

The implementation uses Python 3.10+, Flask 3.1+, Werkzeug, Groq Cloud SDK, Llama-3.3 70B Versatile, Supabase PostgreSQL, SQLite3, HTML5, CSS3 and vanilla ES6+ JavaScript. The database adapter supports persistence operations, while the responsive interface presents learner dashboards, roadmaps, tutor conversations and quizzes. Four principal modules are implemented:

1) **Algorithmic Curriculum Architect:** Generates structured learning modules and daily units according to learner specifications, including estimated time and resource links.
2) **Focus Tracker:** Displays the daily agenda, supports task completion and maintains learning streak information.
3) **Context-Aware AI Code Tutor:** Uses the active roadmap, learner level and target role as context when answering technical questions and assisting with debugging.
4) **Diagnostic Quiz Runner:** Generates scenario-based questions, applies a timer, evaluates answers and provides explanations. A score of 70% is the passing threshold for badges.

A. Functional Validation

The project report describes unit testing, integration and system testing, and user acceptance testing. The functional test suite contains 24 test cases covering key application workflows. The reported result is 24 successful cases out of 24, corresponding to a 100% pass rate. This indicates that the tested workflows operated as expected in the reported test environment; it does not by itself establish learning effectiveness across a wider student population.

B. Performance Evaluation

The report evaluates the Groq TSP inference pipeline against conventional cloud language-model endpoints and local developer instances. It reports curriculum-generation latency below 2.5 seconds, a 90.4% reduction in latency and 5.1× higher token throughput compared with conventional cloud LLM endpoints. It also cites token generation speeds exceeding 500 tokens per second for the Groq and Llama-3.3 configuration. These figures are reproduced as reported project results; independent replication would be required to generalize them.

TABLE I. SUMMARY OF REPORTED FUNCTIONAL AND PERFORMANCE RESULTS

Evaluation measure	Reported result
Functional test cases	24
Functional pass rate	100% (24/24)
Curriculum generation latency	Below 2.5 seconds
Latency reduction	90.4%
Relative token throughput	5.1×
Groq token generation speed	500+ tokens/second

C. Discussion

The combination of generated curricula, daily progress tracking, contextual tutoring and scenario-based quizzes provides a continuous learning workflow. The dual-engine database design supports both cloud and local persistence, while the fallback curriculum generator reduces dependence on an external inference service. The reported results are promising for the prototype; further studies with representative learners, measured learning outcomes and repeated performance tests are needed to establish educational impact.

V. CONCLUSION AND FUTURE WORK

SkillPath AI demonstrates a full-stack adaptive learning platform that transforms learner goals into structured daily technical roadmaps. It integrates low-latency LLM inference, persistent progress tracking, context-aware code tutoring

and scenario-based assessment. The project report records a 100% pass rate across 24 functional test cases and reports sub-2.5-second curriculum generation. Future enhancements include retrieval-augmented generation using official documentation, in-browser code execution sandboxes, voice-driven mentorship and native mobile applications. Evaluation with real learners and independently measured educational outcomes remains an important next step.

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