✅ PROJECT PROPOSAL

EAGLES STUDY COMPANION - PROJECT PROPOSAL

ITAI 2376 - Final Course Project
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1. Problem Statement

Many students struggle with self-directed learning due to three persistent problems:

1. difficulty finding reliable, organized information for their classes,
2. lack of adaptive feedback or personalized instruction, and
3. inefficient study resources that cannot assess progress or adjust difficulty.

Traditional tools such as static websites, non-adaptive study apps, or simple chatbots provide limited educational value. They cannot evaluate a learner's skill level, adjust difficulty automatically, or integrate factual research with guided learning. Additionally, students often rely on scattered sources, inconsistent explanations, and low-quality online content, which increases cognitive load and reduces study efficiency.

The **Eagles Study Companion** aims to solve these problems by providing a **hybrid AI system** that functions as both a **Research Assistant Agent** and

an **Interactive Learning Companion**. The system supports researching complex topics, summarizing credible information, teaching concepts at personalized difficulty levels, generating adaptive quizzes, and tracking user progress over time. This addresses the need for a unified, intelligent educational platform that improves comprehension, retention, and learner agency.

2. Project Option Selection

Although the project guidelines require choosing one of four options, our system intentionally combines elements from **Option 1 (Research Assistant Agent)** and **Option 4 (Interactive Learning Companion)** because the educational domain naturally benefits from both.

Primary Classification:

✔️ **Option 4 - Interactive Learning Companion**

Secondary Functionality:

✔️ **Option 1 - Research Assistant Agent**

Justification for Hybrid Selection

The Interactive Learning Companion requires the system to explain concepts, evaluate progress, and provide adaptive feedback. However, students also need high-quality research support, which is central to Option 1. Combining these ensures:

- Better instructional explanations backed by factual references
- Higher user trust through transparent, sourced information
- Improved learning efficiency through deeper content understanding
- A more complete educational tool aligned with real student needs

This hybrid remains fully compliant with course requirements because it includes:

- A coherent agent architecture
- Tool integrations
- Reinforcement learning elements
- Safety mechanisms
- Transparent reasoning

3. Agent Design and System Architecture

The **Eagles Study Companion** uses a **multi-agent architecture** anchored by a central **Coordinator Agent**. The system follows the ReAct (Reasoning + Acting) model with Chain-of-Thought style internal reasoning and explicit decision routing.

3.1 Architectural Overview

Input Processing

- User messages pass through a safety layer (content filtering, banned topics, and boundary checks).
- Valid queries are tagged by intent (research, explanation, tutoring, or assessment).

Coordinator Agent

- Performs intent classification using LLM-based reasoning.
- Produces structured JSON routing decisions.
- Dispatches tasks to the proper specialized agent(s).

- Implements fallback logic for invalid or malformed responses.

Specialized Agents

A. Researcher Agent (Option 1)

- Conducts information retrieval using simulated web-search tools.
- Summarizes documents using LLM-based extractive and abstractive strategies.
- Evaluates credibility using rule-based heuristics.
- Produces structured reports with citations.

B. Tutor Agent (Option 4)

- Generates personalized explanations based on learner profile.
- Adjusts tone, complexity, and length depending on user progress.
- Provides examples, analogies, and multi-step walkthroughs.

C. Quiz Agent (Option 4)

- Generates multiple-choice quizzes.
- Adjusts difficulty using a reinforcement-style scoring system.
- Tracks performance trends and updates the learner model.

D. Safety Agent

- Rejects inappropriate or harmful queries.
- Enforces boundaries set by course policy.
- Offers safe alternatives instead of performing blocked requests.

Memory System

The system stores:

- prior quiz performance
- learner style (inferred)
- topic familiarity
- interaction count
  These values inform personalized instruction and adaptive assessments.

Output Generation

- Final responses are formatted into user-friendly messages.
- The transparency panel logs:
    - active agent
    - reasoning summary
    - tools used
    - confidence score

4. Tool Selection

The project integrates multiple external tools to meet technical requirements:

Primary Tools

1. **Simulated Web Search Tool**

    - Used by the Researcher Agent
    - Helps gather facts, references, and topic context
    - Agent determines use based on keywords (“definition,” “research,” “find sources,” etc.)

2. **Mathematical Calculator Tool**
    - Used for solving equations and verifying numeric results
    - Activated when input contains identifiable mathematical structures

Secondary Tools

3. **Document Summarization Module**
    - Extracts key points from long text
    - Used by Tutor and Researcher agents
4. **Profile Memory System (Internal Tool)**
    - Stores learner performance metrics
    - Supports long-term adaptation

Error Handling

- Timeout detection
- Invalid JSON fallback
- Tool-not-found recovery
- Safety fallback if tools return unsafe content

5. Development Plan and Milestones

Phase 1 — Planning (Week 1)

- Finalize architecture
- Define agent roles
- Select tools and model endpoints
- Draft prompts for each agent
- Complete proposal (this document)

Phase 2 — Core Implementation (Week 2-3)

- Build Coordinator Agent routing logic
- Implement Researcher, Tutor, and Quiz agents
- Create safety wrapper
- Add learner profile storage
- Implement basic UI in React

Phase 3 — Tool Integration (Week 3-4)

- Connect simulated web search
- Add math solver