Detailed plan for Agents in Learning

| Category | **Description** |
| --- | --- |
| Science Curriculum (Stage 4 - Years 7-8 | Key Content Areas: The Stage 4 Science curriculum is often organized around core concepts. Your agents will need to understand these themes to generate relevant content. They include:   * Working Scientifically (the skills students need to learn and practice) * Physical World (Forces, energy, and motion) * Chemical World (States of matter, atoms, and elements) * Earth and Space (The Earth's systems, astronomy) * Living World (Cells, ecosystems, and human body systems)   NESA Stage 4 (Years 7-8) Science Syllabus: The core document for your curriculum specialist agent. It outlines the aims, outcomes, and content for students. This is the single most important document to feed into your system[https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/science-and-technology](https://www.google.com/search?q=https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/science-and-technology)  Link: The NESA website is the primary source. The direct link is often to the syllabus in PDF or a web-based format. I recommend searching for "NESA Science Stage 4 syllabus" on the NESA website to get the most up-to-date version. |
| Relevant Digital Learning Materials | Jacaranda NSW Science Stages 4 & 5: A popular publisher for Australian school resources. They offer digital textbooks and supplementary materials aligned with the NESA syllabus. They often have free samples or trial periods. Their resources often include videos and interactive activities.<https://www.jacaranda.com.au/subjects/science/nsw-curriculum/>  Cengage Science in Focus: Another widely used textbook series in NSW. They provide digital learning solutions with videos and interactive exercises.<https://cengage.com.au/secondary/science-in-focus-stage-4-and-5> |
|  | Khan Academy: A globally recognized, free platform with videos and exercises for various subjects, including science. It's a great source for conceptual explanations.<https://www.khanacademy.org/science>  ABC Education: The Australian Broadcasting Corporation provides a wealth of free, curriculum-aligned resources, including videos, articles, and games.<https://www.abc.net.au/education/>  AITSL - Learning from Home: The Australian Institute for Teaching and School Leadership (AITSL) often curates lists of free educational resources.<https://www.aisnsw.edu.au/Pages/learning-from-home---pedagogy-2.aspx> |
| Support Materials | YouTube Video Channels   * Crash Course: Known for its high-quality, fast-paced, and engaging educational videos on a wide range of topics, including SciShow: A popular channel that covers a variety of scientific topics with a focus on curiosity and fun facts. * Veritasium: Explores scientific and engineer * ing topics with a focus on "science communication" and is excellent for building deeper conceptual understanding. Science with Skilldog: Has playlists specifically for Australian Curriculum Year 7 and 8 science, which is very closely related to the NSW syllabus. * Mr Leek Science: Features videos on topics directly from the Year 7 science curriculum, such as forces, cells, and atoms. |

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### Building the Agentic System with Google Vertex AI

This is an approach for building multi-agent systems.

Conceptual System Architecture:

Agent Orchestrator (ADK Core): This agent is the brain of your system. It receives a user's request (e.g., "I need help understanding photosynthesis") and decides which specialist agent to route the task to. It uses the ADK (Agent Development Kit) to define the overall workflow.

**Specialist Agents (A2A Protocol):** These are your individual, highly-focused agents that communicate with each other using the A2A (Agent-to-Agent) protocol.

* **Curriculum Specialist**: This agent's primary function is to query and understand the NESA syllabus. When a student needs to learn a topic, this agent identifies the specific learning outcomes and content from the syllabus. It acts as the "source of truth" for what needs to be taught.
* **Learning Specialist:** This agent receives the specific learning outcomes from the curriculum agent. Its job is to generate a lesson plan or a learning pathway. It uses Gemini 2.5 to create text-based explanations and leverages tools to search the digital materials (eLearning books, videos, etc.) to find relevant content.
* **Assessment Specialist:** This agent is responsible for creating quizzes, practice questions, or project-based assessments based on the learning outcomes. It can also evaluate a student's response and provide feedback.
* **Support Specialist:** This agent acts as a "tutor" or "triage" agent. If a student is struggling, this agent provides remedial explanations, finds alternative resources (like a different YouTube video), or breaks down a complex topic into smaller, more manageable parts.

**Tools (MCP):** The Model Context Protocol (MCP) is how your agents connect to external resources. Your agents will use tools to:

* **Search Tool:** A tool built on Google Search to find external links and documents.
* **Code Execution Tool**: A tool to run code snippets (e.g., Python simulations for physics concepts).
* **Data Store Tool:** A tool to access the indexed NESA syllabus, textbook chapters, and other reference materials you've loaded into your system.
* **YouTube API Tool:** A tool to search for specific YouTube videos and get their links and descriptions.

**Step wise Development Plan:**

* Step 1: Environment Setup: Set up a Google Cloud project and enable the Vertex AI API. Get familiar with the ADK and its Python library.
* Step 2: Data Ingestion: Use Vertex AI to ingest and index the NESA syllabus and other digital materials. This will create the "knowledge base" your agents can query.
* Step 3: Agent Scaffolding: Create the Python code for each of your specialist agents using the ADK. Define their roles, instructions, and the tools they can use.
* Step 4: Tool Definition: Write the Python functions that serve as your tools (e.g., a function to search the indexed syllabus).
* Step 5: Orchestration Logic: Write the code for your orchestrator agent. This code will use A2A to manage the flow of information between your specialist agents.
* Step 6: Gemini Integration: Integrate Gemini 2.5 into each agent as the "model." Gemini 2.5's enhanced reasoning capabilities will be critical for your agents to understand complex instructions and generate accurate, context-aware responses.
* Step 7: Testing and Iteration: Use the ADK's built-in evaluation tools to test your agents' performance and refine their behavior.

# Designing an Agentic AI Learning System for Year 7-8 Science

# A Content and Architectural Blueprint

## Vision and Strategic Imperatives

This report provides a comprehensive blueprint for the development of an agentic AI system designed to function as an intelligent learning companion for students in New South Wales (NSW), Australia. The system will be built to support the NSW Education Standards Authority (NESA) Stage 4 Science curriculum for Years 7 and 8. The proposed architecture is based on a multi-agent framework, comprising a central agent orchestrator that directs four specialized agents: a Curriculum Specialist, a Learning Specialist, an Assessment Specialist, and a Support Specialist. This modular design ensures scalability and enables the system to provide a highly personalized, dynamic, and engaging learning experience.

The core strategic imperative is to move beyond a simple content delivery system. The analysis of the NESA syllabus reveals that the "Working Scientifically" outcomes, which focus on skills such as inquiry, investigation, and data analysis, are as fundamental as the content-specific knowledge. Therefore, the AI system must be designed to not only deliver relevant information but also to actively guide students in the practice of scientific inquiry. The report's findings, meticulously curated from publicly available educational resources, demonstrate that a wealth of free and high-quality digital materials exists to support this pedagogical approach. By structuring this content according to a proposed technical data schema, the system can be effectively trained and deployed within the Google Vertex AI ecosystem, leveraging the advanced capabilities of models such as Gemini 2.5 to create a truly agentic and responsive learning buddy.

## 2. The Educational Foundation: Deconstructing NESA Stage 4 Science (Years 7-8)

### 2.1. The NSW Curriculum Framework: Structure and Philosophy

The NSW Stage 4 Science curriculum (Years 7-8) is a mandatory 400-hour course. The curriculum's design is not a static, linear progression of topics but an integrated framework built upon three interrelated strands: Science understanding, Science as a human endeavour, and Science inquiry.1 These strands are interwoven throughout the learning journey, ensuring that students not only acquire foundational scientific knowledge but also develop critical thinking skills and an appreciation for the social and historical context of science.

The curriculum is structured into distinct units of study, with a typical scope and sequence for the year provided by NESA. Key units include Observing the universe, Forces, Cells and classification, and Solutions and mixtures, among others.2 Each unit is associated with specific learning outcomes, identified by a standardized code. For example, the

Observing the universe unit aims to achieve the SC4-OUT-01 outcome, which relates to understanding how observations are used to increase knowledge of the universe, and the SC4-FOR-01 outcome for the Forces unit.2 This structured approach provides a clear roadmap for the AI system, allowing the Curriculum Specialist Agent to track a student's progress against a well-defined set of learning goals.

The architectural design of the AI system must be fundamentally informed by this curriculum structure. A simple content retrieval mechanism would fail to capture the holistic nature of the NESA syllabus. The core of the system’s logic must be built upon the understanding that scientific learning is a process of exploration and skill-building, not just memorization. The curriculum framework itself acts as a guide for the AI's behavior, directing it to constantly encourage and facilitate the skills of scientific inquiry.

### 2.2. The 'Working Scientifically' Framework: A Behavioral Specification for the AI Buddy

A central and critical component of the NESA curriculum is the "Working Scientifically" strand, which outlines a set of skills and processes that students are expected to develop. These skills are explicitly listed alongside the content outcomes for every unit, emphasizing their equal importance.2 These skills include:

* Questioning and predicting: identifying and developing questions for investigation.2
* Planning and conducting investigations: following planned procedures and using scientific tools and instruments safely.2
* Processing and analyzing data: using data to identify trends, patterns, and relationships, and to draw conclusions.2
* Communicating: presenting scientific ideas and concepts using a range of communication forms.2

This framework provides a direct functional specification for the AI learning system. For instance, the Curriculum Specialist Agent cannot merely serve up information about Cells and classification.2 It must work in concert with the

Learning Specialist Agent to ensure the student develops skills like using scientific tools and instruments for observations (SC4-WS-01) and communicating scientific ideas (SC4-WS-08).2 The system's effectiveness is not measured by content mastery alone, but by a student's growing proficiency in these procedural and cognitive skills.

The sample assessment tasks provided by NESA provide a concrete demonstration of how these skills are measured in practice. The "Finding the ideal lunch spot" task, for example, is a practical investigation that assesses a student's ability to use scientific tools and instruments to make observations (SC4-WS-01) and to communicate their research findings (SC4-WS-08).3 Similarly, the "Vertebrate Poster" task assesses a student's ability to locate, process, and present information from secondary sources.4 These tasks provide a clear target for the system's design, linking abstract syllabus outcomes to tangible, measurable student performance. The system's internal data model must therefore be capable of tracking a student's proficiency in these skills over time.

### 2.3. The Curricular Core: The Curriculum Specialist Agent's Role

The Curriculum Specialist Agent serves as the institutional memory and strategic guide for the entire system. Its primary responsibility is to maintain a stateful representation of the student's progress against the NESA Stage 4 Science syllabus, encompassing both the content and the Working Scientifically outcomes. By analyzing the student's current proficiency, the agent can recommend the next best learning unit, module, or specific task to the orchestrator.

A fundamental component of this agent is a well-structured knowledge base that maps the NESA curriculum to a variety of digital resources. This data repository is the foundation of the AI's pedagogical intelligence. The following table provides a sample of this critical data mapping, which can be extended to cover the entire curriculum scope. This table serves as a foundational dataset for the agent, eliminating the need for manual resource curation.

| NESA Unit | Learning Overview | Content Outcomes | Working Scientifically Outcomes | Relevant Resource Type | Resource Title/Description | Source URL/ID |
| --- | --- | --- | --- | --- | --- | --- |
| Observing the universe | The nature of science, practice of science, space science, Aboriginal and Torres Strait Islander Peoples' cultural knowledges of astronomy. | SC4-OUT-01 | SC4-WS-01, SC4-WS-04, SC4-WS-06, SC-WS-08 | Assessment Task | Sample Assessment Task: 'Finding the ideal lunch spot' | <https://education.nsw.gov.au/content/dam/main-education/documents/teaching-and-learning/curriculum/science/science-s4-observing-the-universe-assessment.docx> |
| Forces | Forces in action, magnets in everyday life, simple machines. | SC4-FOR-01 | SC4-WS-02, SC4-WS-05, SC4-WS-06, SC4-WS-07 | E-book Chapter, Quiz, Video | Pearson Science Year 8 Student Book, Chapter 4 sample; Hatzi Science Quizzes, BBC Bitesize Quizlet Link | <https://www.pearson.com/en-au/schools/secondary/science/pearson-science-new-south-wales-7-10/> |
| Cells and classification | Classification of living things, cells. | SC4-CLS-01 | SC4-WS-01, SC4-WS-04, SC4-WS-08 | OER, Video, Quiz | CSIRO Taxonomy and Finding a Better Milk resources; Hatzi Science blog Cells and Habitats quizzes | <https://www.csiro.au/en/education/Resource-Library/Teacher-collaborations> |
| Solutions and mixtures | Properties of matter, properties of water, solutions, separating mixtures. | SC4-SOL-01 | SC4-WS-03, SC4-WS-04, SC4-WS-07 | OER, Lab Simulation | CSIRO Separating Mixtures resource; LabXchange The Egg Lab | <https://www.csiro.au/en/education/Resource-Library/Teacher-collaborations> |
| Geological Change | Energy transfers, chemical change, geological change. | SC4-CHG-01 | SC4-WS-01, SC4-WS-03, SC4-WS-04 | Video, Activity, Quiz | Geoscience Australia Earth is moving video; Hatzi Science blog quizzes; Pearson Science Year 8 sample chapter | <https://www.ga.gov.au/education/classroom-resources> |

## 3. The Learning Repository: A Catalog of Digital Resources for the Learning Specialist Agent

### 3.1. Digital Textbooks and Open Educational Resources (OERs)

The Learning Specialist Agent is responsible for fetching and presenting the most relevant learning materials to the student. The analysis identified a diverse range of resources, from commercial textbook samples to government-produced Open Educational Resources (OERs). This requires the system to have a strategic approach to content curation.

* Commercial Resources: Publishers like Pearson offer sample chapters from their NSW-aligned textbooks and activity books. For Year 7, sample PDFs are available for Chapter 2 of the student book and Chapter 1 of the activity book. For Year 8, samples include Chapter 4 of the student book and Chapter 2 of the activity book.5 Good Science also provides online courses and PDF workbooks aligned with the Australian Curriculum, with the first lesson of each online course available for free.11 These samples are invaluable for filling content gaps and providing a traditional learning structure, but the system must be designed to clearly communicate their limited nature to the end user.
* Government-Backed OERs: The report identified several high-quality, fully free OERs from Australian government bodies. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) provides downloadable PDF resources for teachers with activities for Years 7 and 8 on topics such as Carbon Capture, Energy, Finding a Better Milk, Separating Mixtures, and Taxonomy.8 Similarly, Geoscience Australia offers a wealth of classroom resources, including videos, posters, and student activities on Earth and Space science topics like  
  Earth is moving (tectonic plates), Australian meteorites, and Fossils.10 The system's design should prioritize these resources for core content delivery, as they are a stable and trusted source of information.

### 3.2. Curated Video and Multimedia Content

Video and multimedia content are crucial for creating an engaging learning experience. The Learning Specialist Agent must be able to select and recommend videos based on their pedagogical intent and alignment with specific curriculum topics. The research identified several highly relevant sources.

* Australian-Specific Channels: Science with Skilldog offers playlists specifically for the Australian Curriculum for Years 7 and 8.13 For Year 8, topics include the  
  Rock Cycle and Energy.13 For Year 7, the videos cover  
  Habitats and Simple Machines.14 Another valuable Australian educator is  
  Science Help with Mr C, who creates "Vodcasts" based on mind maps to help students who have missed lessons.15 These videos are highly targeted and can serve as the primary resource for direct instruction on a specific topic.
* Broad-Curriculum Channels: The AI can leverage a wide range of internationally recognized educational YouTube channels for conceptual depth and broader context. The research references channels such as Khan Academy, Crash Course, PBS Eons, and Bozeman Science.17 A deep-dive video from a channel like PBS Eons might be excellent for the  
  Support Specialist Agent to provide conceptual depth or an interesting tangent, while a short, focused "Skilldog" video might be better for the Learning Specialist Agent to explain a specific core concept within a guided lesson. The AI's orchestrator must be able to choose the appropriate resource based on a student's needs and a video's specific pedagogical value, which requires a rich metadata layer for each video.

### 3.3. Interactive Simulations and Virtual Labs

Interactive simulations provide a safe, hands-on environment for students to experiment and explore scientific concepts without the need for physical equipment. This is crucial for developing the Working Scientifically skills. The system's design should enable a seamless interface with these resources.

* LabXchange: This platform offers free, ad-free virtual labs for middle and high school students.9 Simulations cover a variety of topics, including  
  Using a Light Microscope, Stomata Exploration, The Egg Lab (for osmosis), and Photosynthesis and Cellular Respiration.9 These labs are designed to provide real-time feedback and allow students to learn from mistakes, making them ideal for inquiry-based learning.
* PhET Interactive Simulations: Developed by Nobel Laureate Carl Wieman, PhET offers free, research-based simulations that engage students through a game-like environment.20 While the research does not list specific Grade 7-8 simulations, the general topics align well with the curriculum, including  
  Circuit Construction Kit and Collision Lab.21 The system must be designed to capture data from a student's interaction with the simulation—such as the variables they manipulate and the number of attempts—to generate real-time feedback and inform formative assessment.
* Gizmos: This platform offers a large library of interactive STEM simulations for grades 3-12.23 While most resources require a license, they offer a 30-day free trial. The upcoming "Gizmos Investigations" for grades 6-8 are described as fully guided, hands-on lessons built around real-world problems. The  
  Learning Specialist Agent could use the Histograms Gizmo to help students process and represent data, which is a key skill in the NESA curriculum.23 The integration of these simulations transforms the learning experience from a passive link-click to an active, data-rich interaction.

## 4. The Assessment Engine: A Blueprint for the Assessment Specialist Agent

### 4.1. The Role of the Assessment Specialist Agent

The Assessment Specialist Agent is tasked with designing and administering assessments that are a fundamental part of the learning loop. This agent's primary function is not to simply give a final grade but to provide a continuous stream of formative feedback. This feedback helps to identify knowledge gaps and skill deficiencies, allowing the orchestrator to dynamically adjust the learning path. The agent must be capable of evaluating student performance against both the content outcomes and the Working Scientifically skills, such as planning, data analysis, and communication.

### 4.2. Leveraging NESA's Sample Assessment Tasks

The NESA sample assessment tasks provide a direct framework for the Assessment Specialist Agent's logic.

* Practical Investigation: The Finding the ideal lunch spot task is a practical investigation that provides a detailed analytical rubric. The rubric evaluates a student's Relevance of observations, Accuracy of data, and Use of equipment.3 The agent can internalize this rubric to provide real-time feedback to a student working on a similar problem. For example, if a student's data is inconsistent, the agent could prompt them to re-evaluate their observations or provide a mini-lesson on data collection techniques.
* Research and Communication: The Vertebrate Poster task requires students to gather, summarize, and present information from secondary sources.4 The NESA website provides graded student work samples for this task, which are invaluable. An AI system could use these examples to train its own scoring model, allowing it to provide nuanced feedback on a student's work based on criteria like the appropriate acknowledgment of sources and the application of a poster format.4 The graded samples serve as a ground truth for evaluating AI-generated responses and for training the  
  Assessment Specialist Agent's scoring model.

### 4.3. Quizzes and Practice Questions: The Formative Layer

In addition to complex tasks, the Assessment Specialist Agent can generate and administer a variety of quizzes for quick, formative checks.

* Targeted Quizzes: The research identified several online quizzes that can be used or emulated. Studiosity offers a Forces and Energy Quiz with 20 questions covering core concepts like conservation of energy and Newton's laws.25 The Hatzi Science blog provides links to quizzes on specific topics such as  
  Cells, Magnets, and Forces.6 The Wayground platform hosts quizzes on  
  Lab Safety and Matter, which are useful for foundational knowledge checks.22 These resources provide a large database of questions that the agent can draw upon to assess student understanding throughout a unit.
* ACARA Work Samples: The Australian Curriculum, Assessment and Reporting Authority (ACARA) provides work samples for Year 7 and 8 science that include examples of written tests and investigation reports.26 These samples serve as models for the types of written and analytical assessments that the AI should be able to handle. By analyzing the student's performance on these assessments, the  
  Assessment Specialist Agent can provide targeted recommendations, signaling the Learning Specialist Agent to re-engage with a topic if a student is struggling.

## 5. The Human-Centric Component: The Support Specialist Agent

### 5.1. The 'Buddy/Friend' Persona: Providing Context and Encouragement

The user's request for a "learning buddy/friend" indicates a need for a system that goes beyond simple information retrieval. The Support Specialist Agent is the component that fulfills this human-centric role. Its purpose is to provide context, motivation, and emotional support, fostering a positive and engaging learning environment. This agent can provide a personalized, empathetic interface that encourages curiosity and perseverance.

### 5.2. Connecting Science to the Real World and Careers

A key function of the Support Specialist Agent is to contextualize scientific learning by linking it to real-world applications and career pathways. This aligns with the NESA Science as a human endeavour strand.

* CSIRO and Geoscience Australia: The CSIRO provides resources that link science topics to careers in STEM.28 For example, when a student is learning about geology, the agent can pull up videos on the work of exploration geologists.28 Geoscience Australia also offers resources that connect its work to the Australian community, providing a rich source of real-world examples for the agent to reference.12
* University Outreach: University outreach programs, such as those from the University of Wollongong, provide additional resources that connect students' passions with STEM skills.30 The agent can use this information to inspire students and help them envision their future, moving the system from a passive knowledge tool to an active mentor. This strategic integration of career-focused content transforms the system from a simple tutor into a holistic learning companion.

## 6. The Technical Blueprint: Agentic Architecture and Data Schema

### 6.1. A Proposed Data Schema for the AI System

To facilitate seamless communication and action among the specialist agents, a standardized data schema is essential. The following schema, presented in a table format, provides a blueprint for how all collected resources can be structured for ingestion and use by the AI system.

| Field Name | Data Type | Description | Example |
| --- | --- | --- | --- |
| ID | String | Unique identifier for the resource. | resource\_nesa\_scope\_seq |
| Resource.URL | String | The URL of the resource. | https://education.nsw.gov.au/.../science-s4-sample-scope-and-sequence.DOCX |
| Resource.Title | String | The title of the resource. | Science S4 Sample Scope and Sequence |
| Resource.Type | String | The type of resource. | Syllabus, Video, E-book\_Chapter, Interactive\_Lab, Quiz, OER\_PDF |
| Curriculum.Alignment | List of Objects | An array of curriculum alignment objects. | `` |
| Curriculum.NESA\_Outcomes | List of Strings | A list of NESA outcome codes. | `` |
| Pedagogy.Learning\_Objective | String | A brief description of the learning objective. | Explain the relationship between kinetic and potential energy. |
| Pedagogy.Intended\_Agent | String | The specialist agent for whom the resource is primarily intended. | Learning Specialist, Assessment Specialist, Support Specialist |
| Metadata.Difficulty\_Level | String | The estimated difficulty level of the resource. | Foundational, Core, Extension |
| Metadata.Description | String | A detailed description of the resource's content. | An interactive simulation showing energy transfer in a roller coaster ride. |
| Metadata.Source | String | The source of the resource. | NESA, Pearson, YouTube, CSIRO, PhET |

### 6.2. The Agent Orchestrator Workflow: A Typical Learning Session

The Agent Orchestrator is the central command module that coordinates the specialized agents. The user's query references the Agent Development Kit (ADK) and Agent-to-Agent (A2A) communication, which are foundational to this proposed workflow. A typical student learning session would proceed as follows:

1. Student Query: A student initiates a request, such as "Help me with the Rock Cycle."
2. Orchestration: The Orchestrator receives the query and, using the ADK, routes the request to the Curriculum Specialist Agent.
3. Curriculum Alignment: The Curriculum Specialist Agent consults its internal knowledge base to identify the relevant NESA topic (Rock Cycle) and associated outcomes (SC4-GEA-01 from the Earth and Space strand).2 It then returns a list of recommended learning objectives.
4. Learning Resource Selection: The Orchestrator passes the objectives to the Learning Specialist Agent. This agent queries the resource repository (structured according to the schema in Section 6.1) to find the most appropriate resource. It might select a foundational video like Rock Cycle 1 - Introduction to Rocks and Minerals from Science with Skilldog 13, or an OER from Geoscience Australia like the  
   Earth Science 101 - The rock cycle video.10
5. Interactive Engagement: The Learning Specialist Agent delivers the resource and monitors the student's engagement. If a student is struggling, the Orchestrator may signal the Support Specialist Agent to provide a contextual explanation or offer encouragement. If the student indicates readiness, the Orchestrator routes the request to the Assessment Specialist Agent.
6. Formative Assessment: The Assessment Specialist Agent generates a short, formative quiz based on the learning objectives. It could pull questions from a resource like the Hatzi Science blog.6
7. Performance Analysis and Recommendation: The Assessment Specialist Agent analyzes the student's quiz performance. If the student performs well, the Curriculum Specialist Agent updates the student's progress and the Orchestrator suggests the next topic. If the student struggles, the Learning Specialist Agent provides a new learning resource, such as an interactive lab from PhET, to help them practice the concept.21

### 6.3. Leveraging the Google Vertex AI Ecosystem

The proposed agentic system is ideally suited for the Google Vertex AI ecosystem.

* Gemini 2.5: The multimodal capabilities of models like Gemini 2.5 are critical for certain tasks. For instance, the Assessment Specialist Agent could use Gemini to analyze an image of a student-created Vertebrate Poster (based on the NESA sample task) and evaluate its content, layout, and visual appeal against the provided grading criteria, replicating the human teacher's process.4
* Vertex AI Search and Vector Search: The vast repository of learning resources can be semantically indexed using Vertex AI's vector search. This would allow the agents to find contextually relevant materials beyond simple keyword matching, ensuring that the student receives the most appropriate and personalized content.

## 7. Conclusions and Recommendations

### 7.1. Final Recommendations for Development

The development of this agentic AI learning system is a complex, multi-phased project. A strategic, phased approach is recommended to ensure a successful and scalable implementation.

* Phase 1: Foundational Content Delivery: The initial phase should focus on the core functionality of the Curriculum Specialist and Learning Specialist agents. The priority is to build the foundational data schema and populate it with a critical mass of high-quality, free digital resources, focusing on the core content strands of the NESA curriculum. The initial goal is to provide a reliable and accurate content delivery service.
* Phase 2: Interactive Engagement and Assessment: Once the content delivery is stable, the focus should shift to the Assessment Specialist and Support Specialist agents. This phase involves integrating interactive labs and quizzes and developing the logic for dynamic, formative feedback. The system would begin to provide a more engaging, personalized, and responsive learning experience.
* Phase 3: Full Agentic Orchestration: The final phase involves fully integrating all four agents under the Orchestrator. The system will mature into a truly "learning buddy," with the ability to provide holistic support, track long-term skill development, and offer aspirational guidance based on real-world connections.

### 7.2. Measuring Success

The success of the AI learning system should be measured using a multi-faceted approach that extends beyond simple metrics. The following Key Performance Indicators (KPIs) are recommended:

* Student Engagement: Track metrics such as session duration, resource completion rates, and the frequency of voluntary interaction with the Support Specialist Agent.
* Proficiency Gains: Measure student performance on assessments, focusing not only on content knowledge but also on proficiency gains in the Working Scientifically outcomes.
* User Satisfaction: Conduct surveys and interviews to gather qualitative feedback on the "buddy" persona, the system's ease of use, and its overall perceived value.
* Resource Utilization: Monitor the usage patterns of different resource types (videos, simulations, text) to inform future content acquisition and development.

By adhering to this comprehensive blueprint, the development team can construct a powerful and pedagogically sound AI learning system that truly supports and empowers students in their scientific journey.

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