

Designing for Reflective Learning: A Voice-Based Assistant for Intentional LLM Use in Education

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LLM



Outline of Presentation

- » Introduction and Reciprocal Adaptation
- » Concerns about LLM usage and proposed solutions
- » Initial Results and Future Works
- » Conclusion of the presentation



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Technology in our lives

Advances in technology have changed our lives

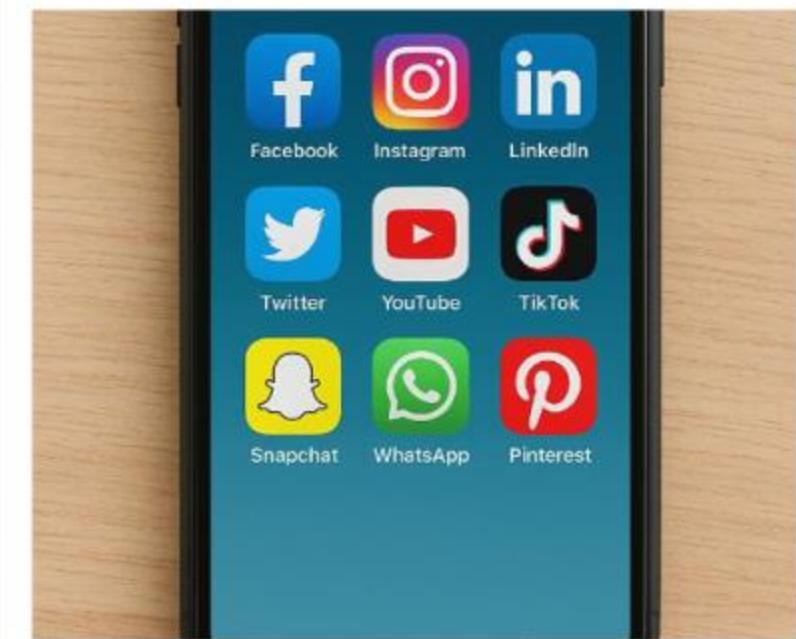
Present in nearly every aspect of everyday life



Image generated by ChatGPT September 2025



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Reciprocal Adaptation



- » One critical concern accompanying technological adoption is the reciprocal adaptation between users and intelligent systems. (Søraker & Brey, 2007)
- » While these systems are designed to meet human needs, users often alter their **behaviors**, sometimes in unanticipated or detrimental ways.



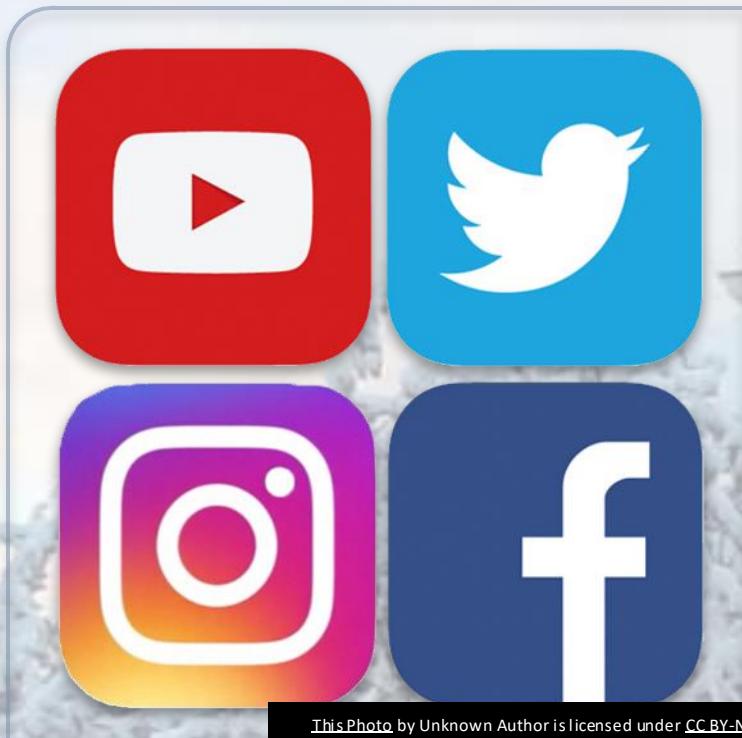
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Reciprocal Adaptation cont.



- » Television contributes to a more sedentary lifestyle.
 - » “Couch potato syndrome.”
 - » Linked to:
 - Laziness.
 - Obesity.
 - Mental Health Issues.

Reciprocal Adaptation Cont.



- » Social media/cellphones contribute to reduced attention spans and compulsive usage.
- » “Reels” deliver information and entertainment in short snippets
- » Reduces the ability to engage with long-form content



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Research Question



Gemini

The Gemini logo consists of the word "Gemini" in a blue and purple gradient font, with a small sparkles icon above the letter "i".

With the recent rise in student use of LLMs, can LLM use lead to unintended changes in learning behaviors?



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Related Works

- » Studies show LLM improves students learning; effectiveness varies on usage (Lehmann et al., 2025)
- » LLM used to encourage class discussion and address limited student-teacher interaction (Ito, Kochigami, & Kanda, 2025)
- » Robots and chatbots enhance student interaction and engagement (Dimitriadou & Lanitis, 2023)

How Students are Using LLMs

An **Index Out of Bounds error** happens when your code tries to access an element of an array, list, or similar data structure using an index (position) that does not exist.

Example in different languages:

Python:

```
python  
  
arr = [10, 20, 30]  
print(arr[3]) # ✖️ IndexError: list index out of range
```

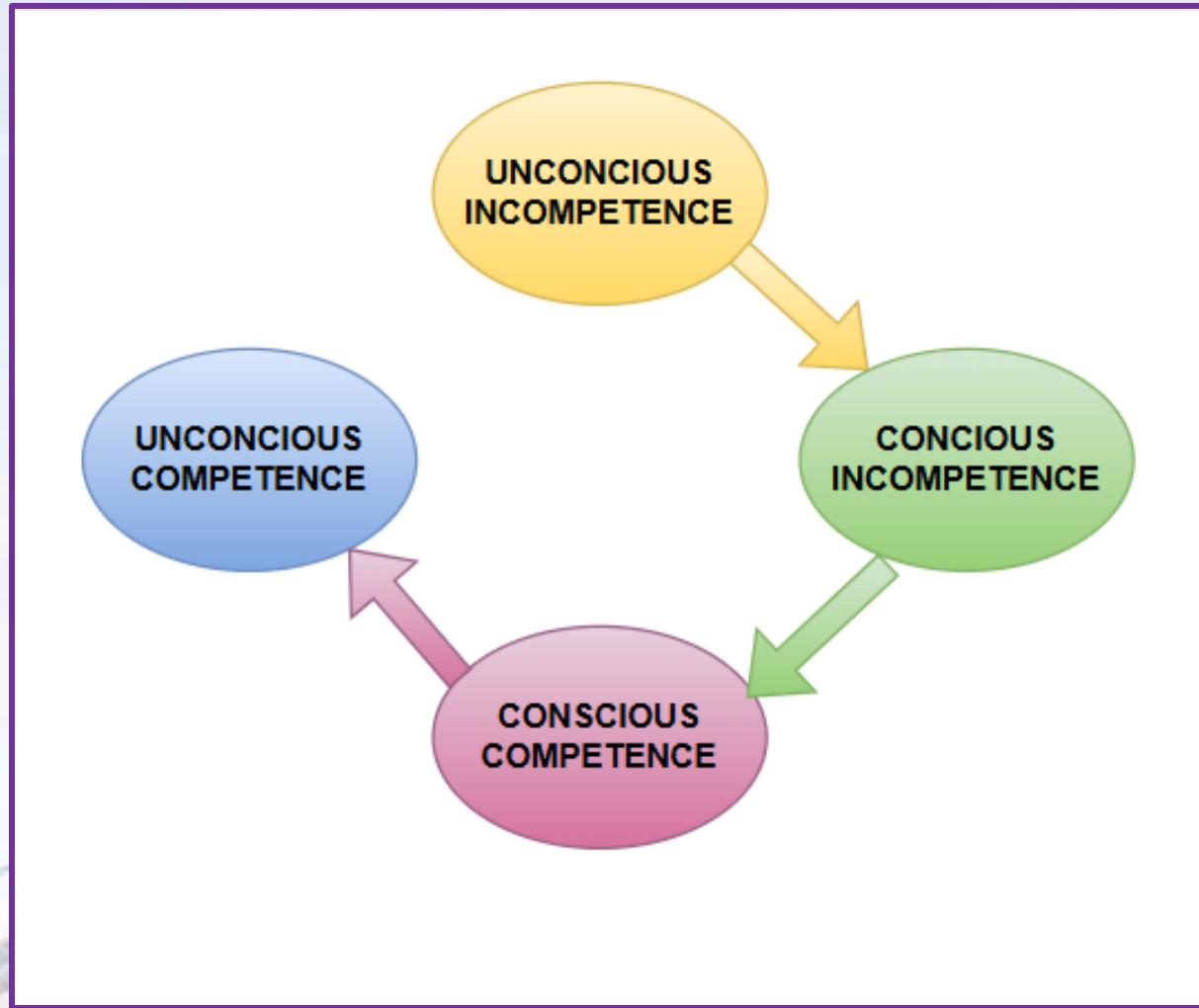
Here, `arr` has 3 elements, indexed `0, 1, 2`. Trying `arr[3]` fails.

Java:

- » Personalized Learning
- » Code Explanation/Debugging
- » Writing Assistance
- » Career Preparation
- » Idea Generation



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Learning Process

- » Learning requires time, reflection, and sustained effort
- » Developed and popularized by Martin Broadwell and Noel Burch in the late 1960s and 70s.

Adapted from *The Four Stages of Competence*, developed by Noel Burch, Gordon Training International, 1970s.



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Concerns About AI/LLM Use in Education



- AI-Assisted Cheating
- Large risk present for students to become dependent on LLM generated responses, lowering the capacity to independently thinking/solving problems.
- Students may be exposed to LLM “hallucinations” and misinformation.

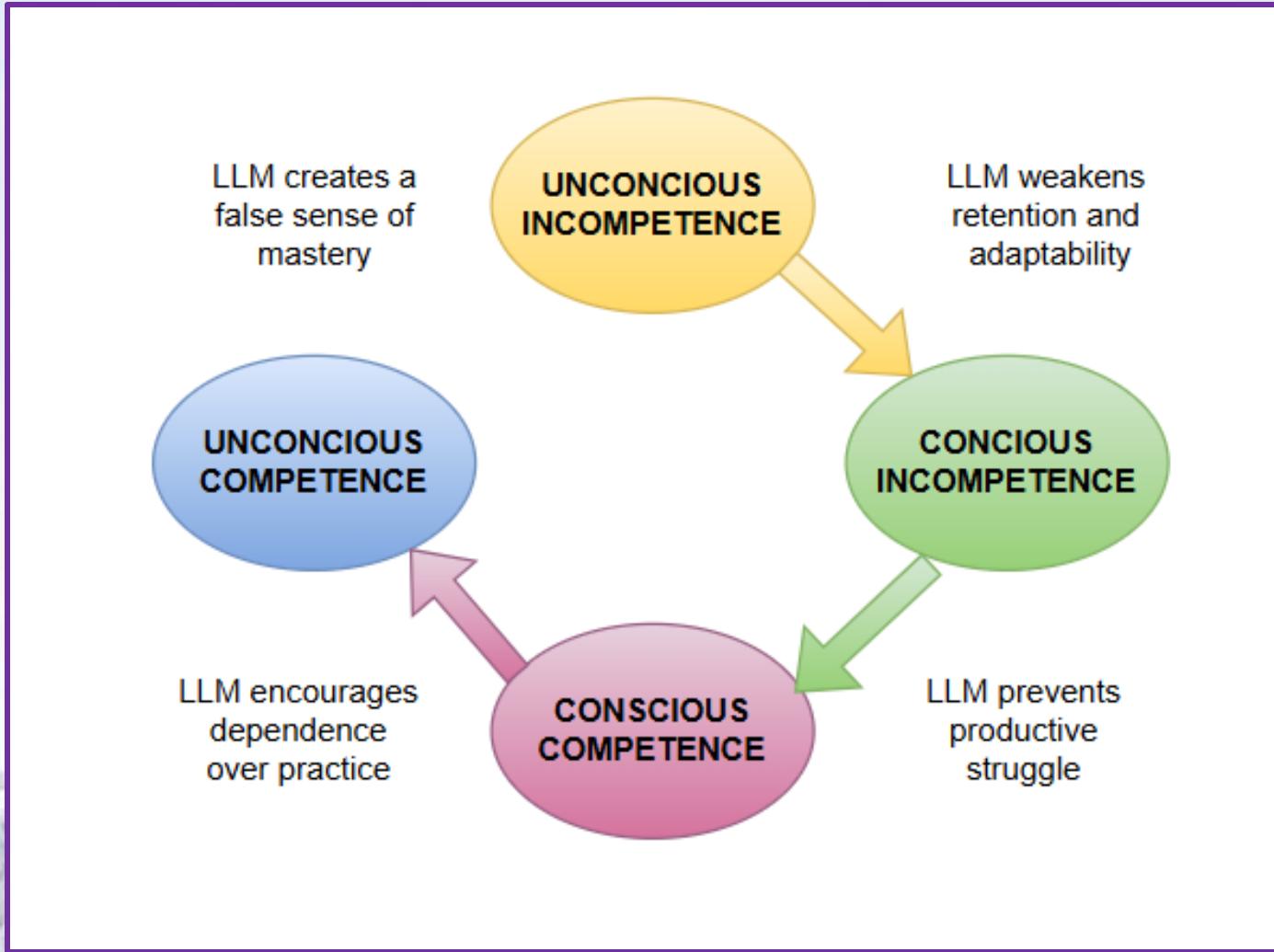


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How Educators are Responding



- » AI detection tools such as Turnitin.
- » Educators redesigning assignments to emphasize higher-order thinking, creativity, and reasoning.



Potential Risks of LLM Learning

- » The ease of generating text and receiving instant responses from AI tools can **hinder** genuine learning by limiting critical thinking, active practice, and deep comprehension.



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Our Goal

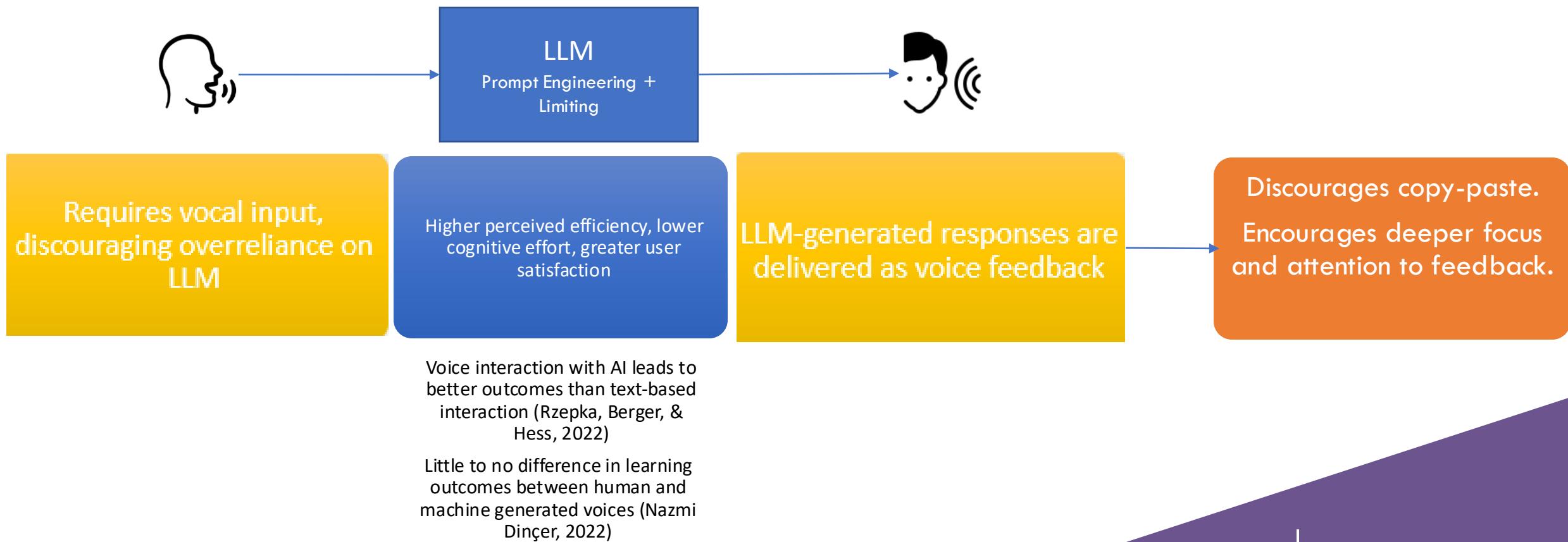


- » Address how the instant outputs of LLMs may disrupt the learning process by encouraging habits of **immediate gratification** and **passive knowledge consumption**.
- » Promote education on using LLMs as learning tools, not shortcuts
 - Encourage alternative, active methods of interaction
 - Discourage over-reliance on AI
- » Encourage ethical, responsible engagement with AI tools.

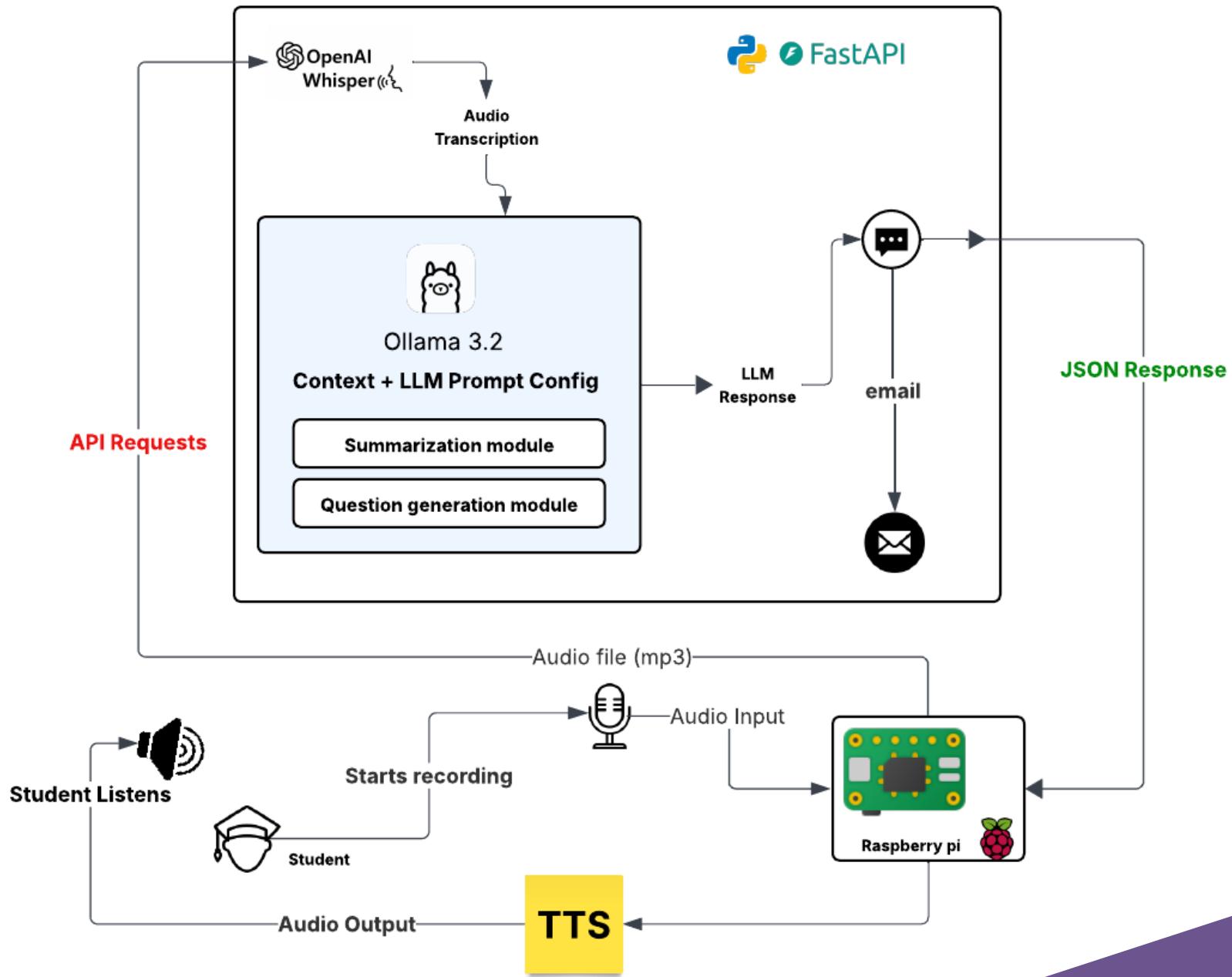


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Proposed LLM Interaction for Learning



System Architecture



Functionality



LECTURE
RECORDING AND
TRANSCRIPTION.



AUTOMATIC
SUMMARIZATION.



STUDY QUESTION
GENERATION.



VOICE-ENABLED
INTERACTION.

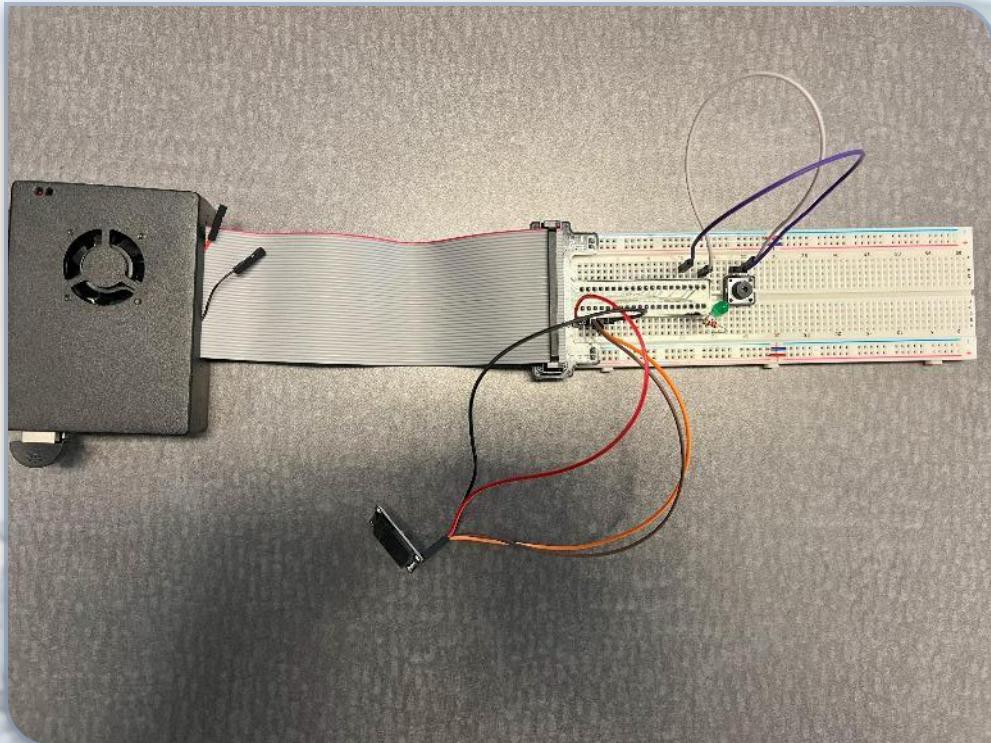


EMAIL DELIVERY OF
GENERATED
CONTENT.



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Implementation: Hardware



Raspberry Pi 4B

- 1.5GHz quad-core processor.
- 2GB LPDDR4 memory
- Bluetooth 5.0
- 64-bit Debian OS.
- 32GB microSD card.

OLED Screen.

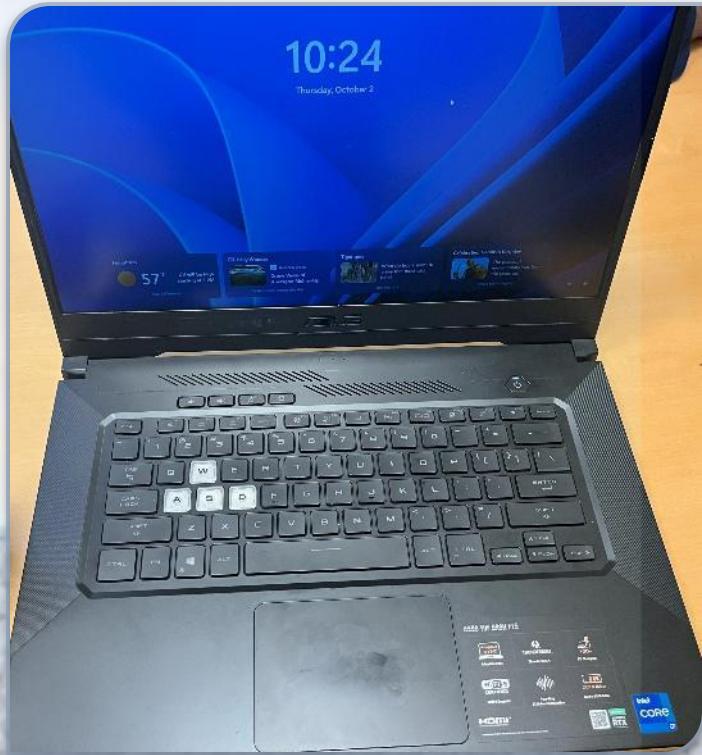
USB microphone

Bluetooth speaker.



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Implementation: Hardware (cont.)

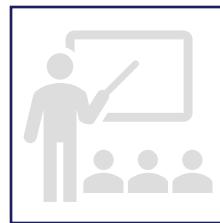


- » Laptop “server”
- » i7-11370H processor.
- » 16GB memory.
- » Nvidia RTX 3060 GPU (6GB video memory).

Prompt Engineering + Limiting



LLM powered all interaction.



Tailored prompts for each function.

"Generate 10 study questions based on this lecture:"

"Give a concise response to aid learning and guide the user without revealing the answer immediately:"



Prompt-limiting feature to promote intentional use and reduce overreliance.

Users are capped at 5 queries/session.

Designed to balance access to AI assistance with cognitive engagement.

Encourages students to reflect on the material rather than rely on automated responses.



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Preliminary Results

Our primary objectives were twofold:

- To demonstrate the system's complete end-to-end operation
- To assess the quality and pedagogical relevance of the generated output

Designing for Intentional Interaction

- Voice as Intentional Friction
- Prompt Scarcity via Session Limits
- Processing Delay as Reflective Pause

Qualitative Analysis of Generated Content

- Outputs from Whisper transcription and LLaMa 3.2 generation pipeline were evaluated for relevance, coherence, and educational utility.
- Initial results indicate that the summaries are coherent and contextually appropriate, while the study questions demonstrate a balanced level of difficulty and alignment with core lecture themes



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Excerpt from Transcribed Presentation: "...just as if you're having a conversation with a real tutor being able to summarize lectures something that llm technology is good at is you can put in a chunk of text and say summarize this in a different way and it's able to explain things in a different way so that's one of the things that we wanted to do in the classroom. in a way you better understand also you'd receive text-to-speech responses so you wouldn't have to read anything on the screen you just listening to the response that the device is giving you ..."

Generated Summary (from device): The speaker is developing an AI-powered device that uses large language models (LLMs) to assist students with learning. The device takes voice input, transcribes it, and generates text responses based on LLM output. The goal is to create a conversational interface that encourages active listening, deep thinking, and problem-solving skills. The device aims to support traditional LLM use by forcing users to engage in a true conversation, rather than simply copying pre-generated responses. This approach is intended to promote soft skills development and effective learning in the classroom.

Generated Study Questions (from device):

1. How does the proposed device use voice transcription to interact with users?
2. What are some concerns about using LLMs like ChatGPT for academic writing and research?
3. How does the proposed system aim to differentiate itself from traditional LLM use, and what benefits do these differences bring to users?
...
10. How does the device's design promote the development of soft skills, such as active listening and deep thinking?

Preliminary Results



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Future plans



- Conduct **empirical studies** to evaluate:
 - Learning habits
 - Knowledge retention
 - Student attitudes toward AI
- **Broader Contribution**
 - Advances the conversation around:
 - **Ethical AI design**
 - **Pedagogically aligned AI tools**
 - Emphasis on building AI systems that are:
 - Not just *intelligent*, but also
 - *Responsible and learner-centered*



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Conclusion

- By incorporating voice input, prompt limitations, and response delays, our system promotes slower, more reflective use of LLM
 - Encourages critical thinking and independent reasoning rather than giving answers.
- Feasible for system to reinforce learning and guide student reflection.
- A **limitation** of our system is that it only works if students choose to engage with it.



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References

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- **Lehmann, M., Cornelius, P. B., & Sting, F. J. (2025).** AI meets the classroom: When do large language models harm learning? *arXiv preprint arXiv:2409.09047*. <https://arxiv.org/abs/2409.09047>



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Thank You 😊



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