

# Designing AI Driven Voice Virtual Assistants for K-12 Students

Jyotirmay Gadewadikar, Jennifer Kuczynski

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# Agenda

- MIT System Design and Management & MITRE Collaboration
- Virtual Assistant Design Recommendations
- University of Virginia & MITRE Collaboration
- Prototype results

# MIT System Design and Management & MITRE Collaboration

## Challenge Summary

- To create an engaging user experience for achieving a great degree of satisfaction in voice virtual assistants with interaction that mimics a human conversational style, remains a progressive area of research and currently a big challenge [1].
- This project will focus on design of a virtual assistant for K-12 at home education, a promising and impactful use case.

## Challenge Objective

*What is the objective of this project? (check one or more)*

- Bring a new cutting-edge technology from lab to market
- Enhance a product or service by infusing new technologies
- Investigate a troubling product, service or organization, and suggest improvements
- Extract lessons from a case study of a project that was particularly successful or unsuccessful

## Problem Context, Known Elements, Uncertainties & Priorities

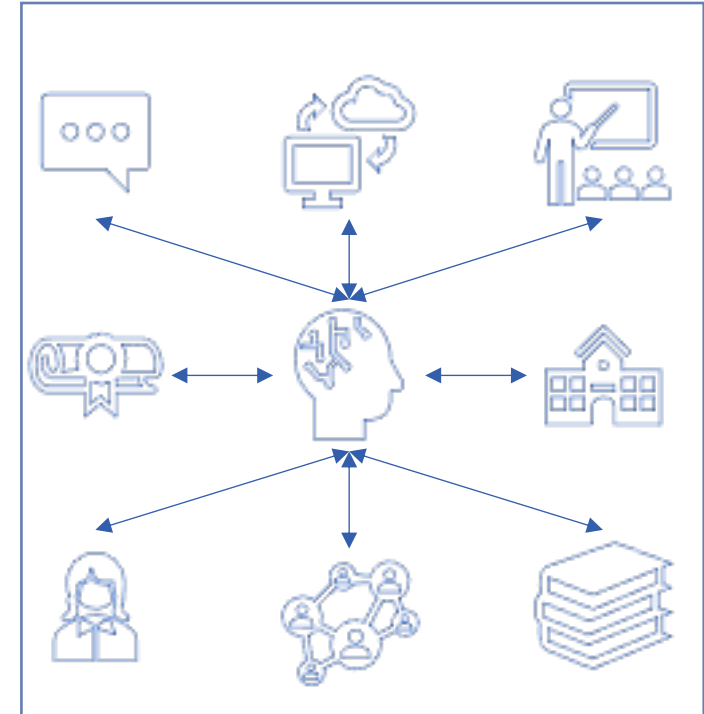
Tools/approaches to be used/explored: System Architecture; Systems and Project Management, Technology Strategy

- Context and Known Elements:** Voice virtual assistants are ubiquitous; however, the technology is new and underdevelopment. Rigorous System Design methods will help better management of these products [1]. There is a lot of emphasis on commercial applications, however areas such as education are less explored.
- Uncertainties:** Design is dependent on the stakeholder inputs, there exist multiple stakeholders with diverging point of views.
- Priorities:** An easily adaptable frameworks to adopt system engineering rigor to design voice virtual assistants does not exist and will be very beneficial to the community
- MITRE Support:** MITRE expert swill provide comprehensive system design guidance, and methods to design voice virtual assistants. MITRE experts will provide or suggest point to contacts for stakeholder inputs such as parents, teachers etc.

## Sample Design Processes

### SE Process Category Output

SE Process	Category	Output
Business or mission analysis	Technical	Virtual Assistant Business requirements
Measurement	Technical Management	Virtual Assistant Key Performance Indicators
Architecture definition	Technical	Virtual Assistant System architecture
...	....	....
System analysis	Technical	System specific data and information
....	....	....
....	....	....



## Project Sponsors

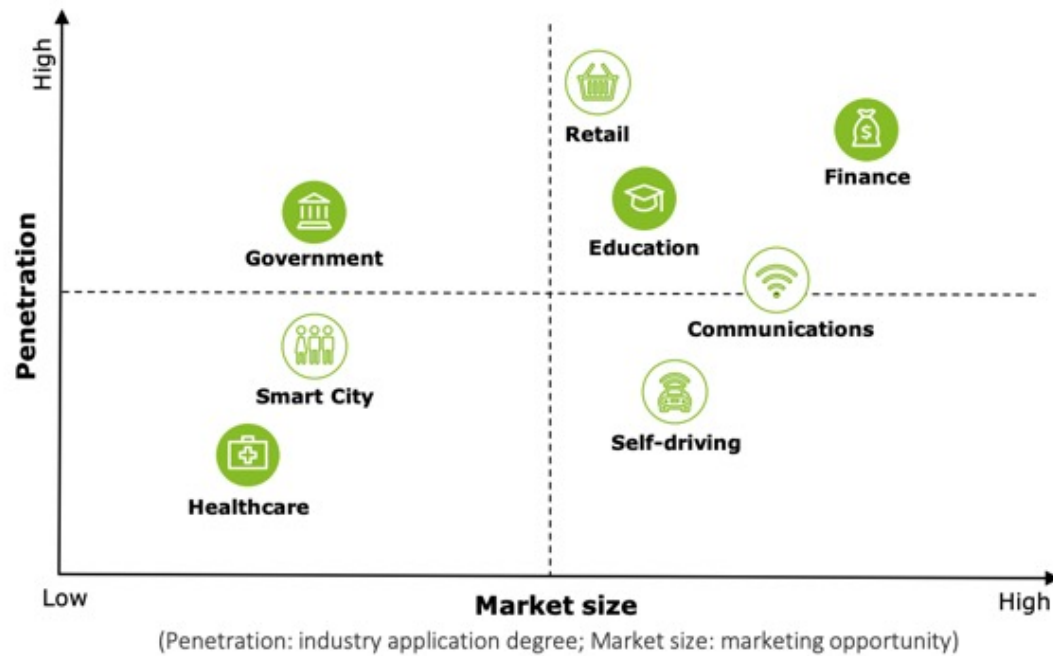
- MITRE Corporation, POC: J. Gadewadikar, Aleksandra Markina-Khusid, SDM'12  
[jgadewadikar@mitre.org](mailto:jgadewadikar@mitre.org), [amk@mitre.org](mailto:amk@mitre.org)

## References

- [Best Practices in Developing Conversational Systems](#)
- <https://www.incose.org/products-and-publications/se-handbook>

# Motivation

## Digital Voice Virtual Assistants in K-12 Education



*Global AI Development Whitepaper, Deloitte, September 2019*

**MITRE** supports many complex SE and System of Systems (SoS) efforts for the Federal Government

**AI-Driven Digital Voice Virtual Assistants:** Efficient, more democratic, have an easier interface, and allow personalization

**Challenges:** Current solutions not designed and built for education especially k-12 and must address issues such as data privacy / parental concerns and bias. System Engineering Practices are also not explored in depth

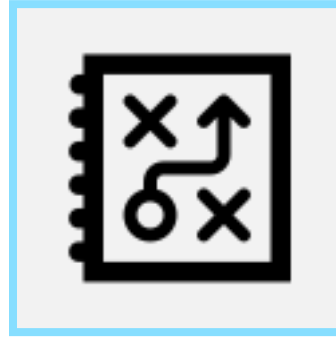
**Facts:** Estimated US expenditure per student per year is \_\_\_\_\_ with approximately \_\_\_\_\_ million students and \_\_\_% of schools offered at least one course entirely online pre\_\_\_\_\_.

# K-12 Education Virtual Assistant Design Space



## Informational

Provide information to students using a Q&A database



## Virtual Quiz Master

Ask questions, process answers, assess learning



## Teacher Assistant

Monitor and track student progress, help stay on schedule

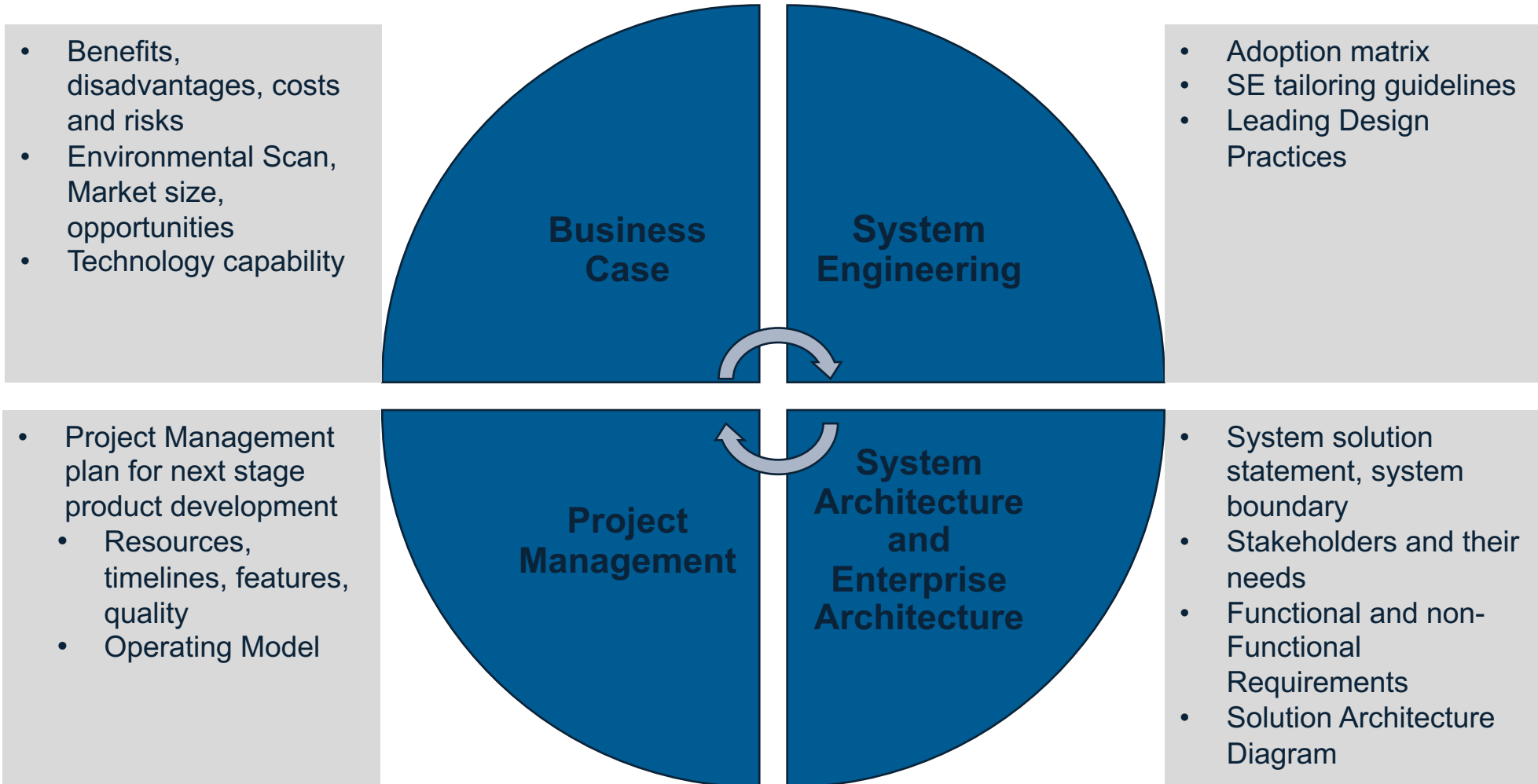


## Intelligent Teacher

Replace traditional manual teaching

1. Create an engaging personal experience for students; customize based on grade, subject and attained knowledge; facilitate analytics and reporting in the product which can continuously improve.
2. Combine system engineering, user experience, system and project management, system architecture, and AI to understand and respond to free form voice, hands free!

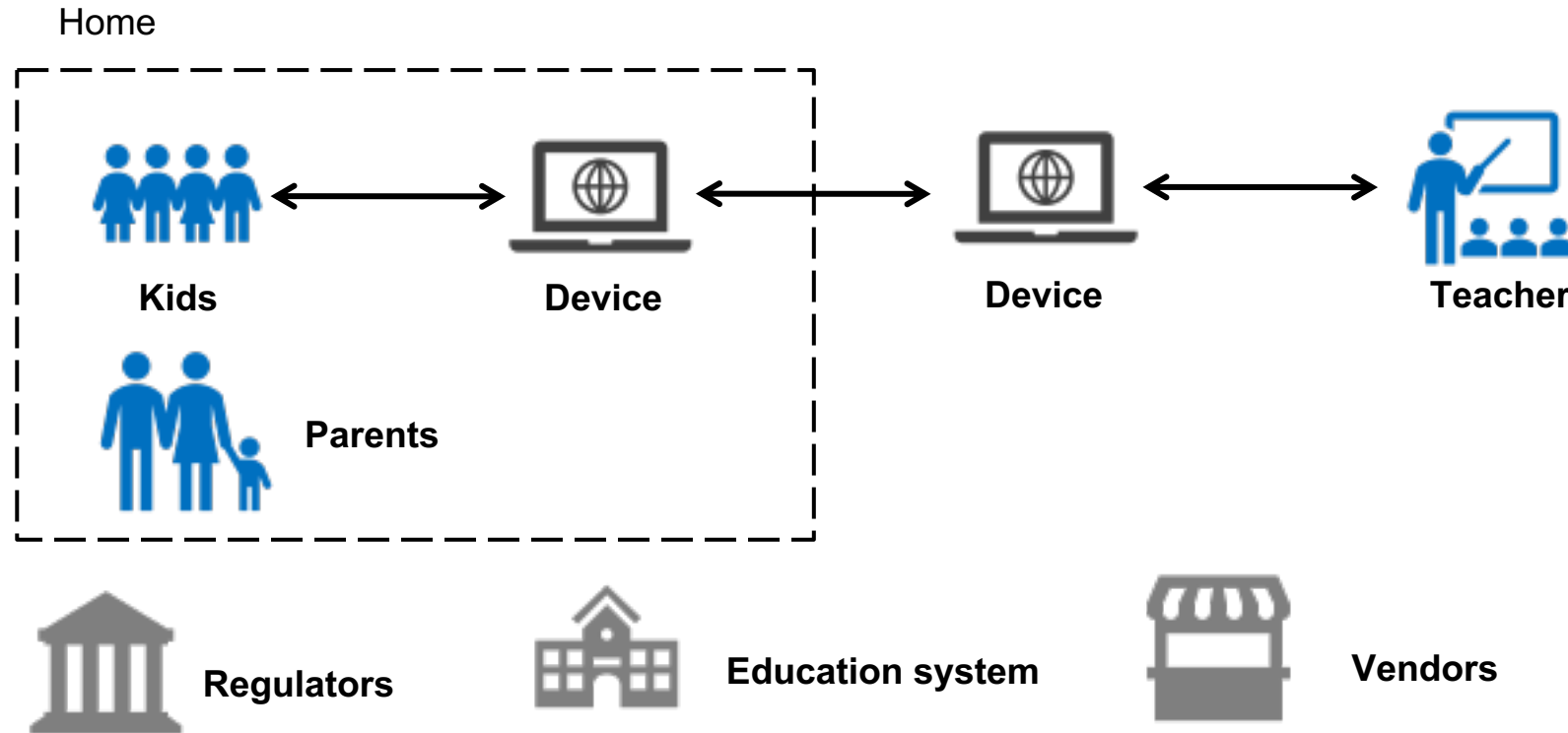
# Target Accomplishments



# Virtual Assistant Design Recommendations



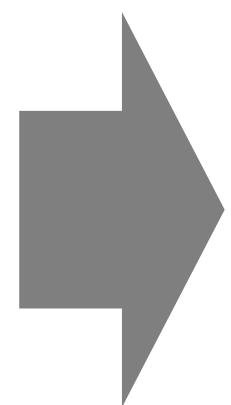
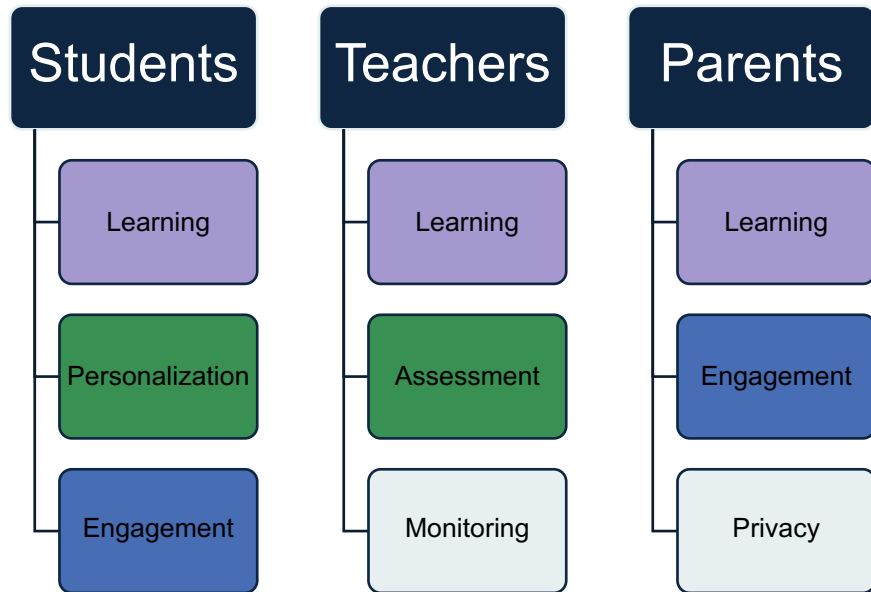
# Key Stakeholders Identified



**Conclusion – focus on kids, parents and teachers**

Based on MIT-MITRE Collaboration

# Needs Identification



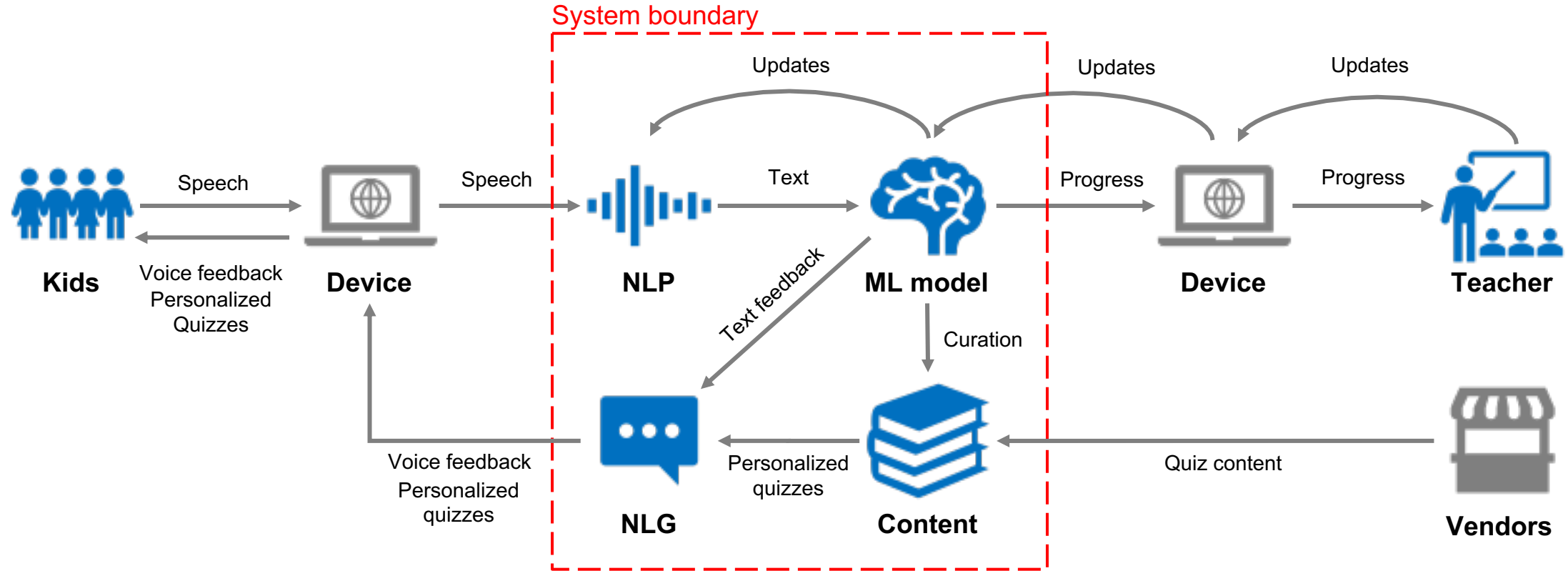
To improve **learning** in K-12 ...

... by delivering **personalized assessment** in an **engaging, conversational style**

... using **audio-based, AI-powered software.**

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# Identified System Boundary

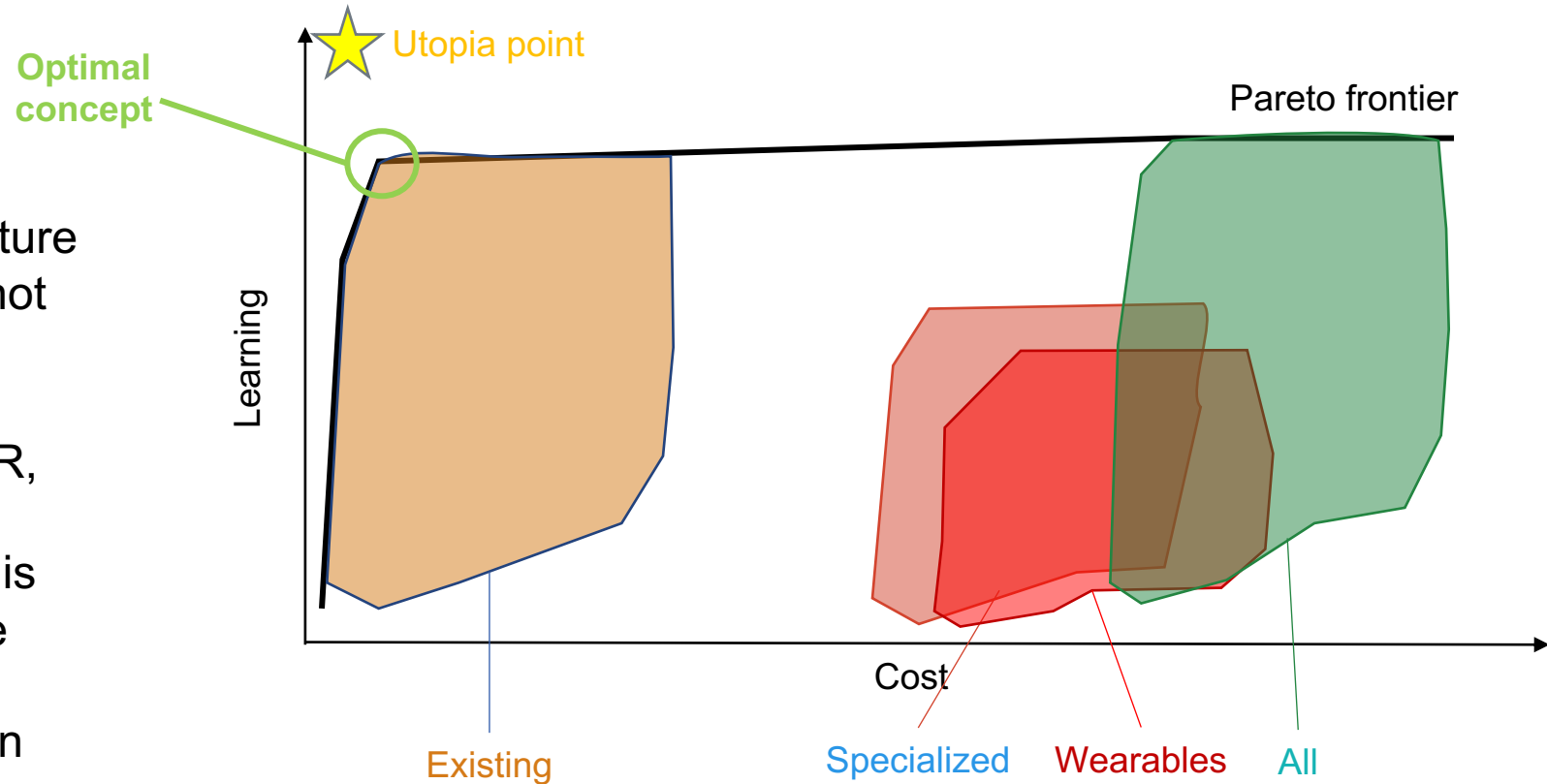


The system boundary excludes devices

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# Making Architectural Decisions

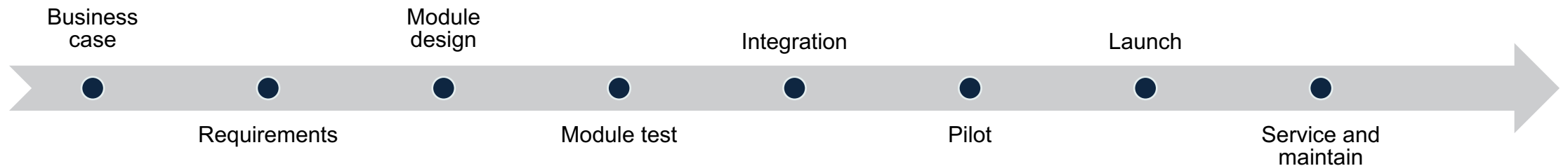
- 7 architectural decisions
- 5184 possible concepts
- Metrics for learning, cost
- Identified optimal architecture
- Customized hardware is not worth the additional cost
- No trade off learning vs. privacy (e.g. COPA, GDPR, CCPA)
- Cloud-based architecture is always preferable at scale
- Multi-user introduces additional risk, at uncertain benefit
- Reporting functionality are worth the additional cost



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# Design Recommendations

- **Cloud-based software** that can be accessed from laptops and tablets
- **Rapidly develop and pilot** a MVP as early as possible, with a small, co-located team
- Include **monitoring functionality** and full data and content review in the scope



Based on MIT-MITRE Collaboration

# University of Virginia & MITRE Collaboration

# MITRE-UVA Collaboration Objective

MITRE is sponsoring a capstone project to prototype a voice assistant model that can address financial literacy questions, comments, and concerns in the classroom. The virtual voice assistant will improve financial literacy by offering lessons that will cover all topics within the National Standards in K-12 Personal Finance Education educational curricula.



# Prototype Creation



## Lesson Plan Content Identification

Employment and income, spending and saving, investing, credit and debit, risk management and insurance, and financial decision making from the National Standards in K-12 Personal Finance Education



## Conversation flow Implementation in Cloud

Google Dialogflow CX interface with a visual conversational flow builder, with CX Phone Gateway. Voiceflow used to visually map out the conversational flows of the lessons



## System Evaluation

Effectiveness of the voice assistant in delivering the content of the lesson plans, the robustness of the voice assistant's understanding of the users' interactions the level of engagement from the voice assistant



# Prototype Results

- Content Created and Implemented
  - Kindergarten Spending and Saving
  - Fourth Grade Credit and Debit
- Evaluation Method Created
  - Compiled metrics across all conversations (lessons) into averages and totals for analysis
  - Utilized individual interactions within each conversation for more detailed results
- Standard Operating Procedure Written
  - Cookbook for building the virtual assistant
- Undergoing Testing

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Jyotirmay Gadewadikar, Chief Engineer Enterprise AI – Systems and Mission Analysis

[jgadewadikar@mitre.org](mailto:jgadewadikar@mitre.org)



[@JyoGadewadikar](https://twitter.com/JyoGadewadikar)



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