



# Audio Reality

Assignment #5: Low-fi Prototyping and Pilot Usability Study

CS 147 - Assistive Technology and Accessibility

Kylie H, Pramod K, Manuel R

# Introduction

## **Value Proposition**

Harnessing augmented reality to create equal educational spaces.

## **Mission Statement**

Improve the accessibility of speech-based education for students with hearing impairments.

## **Problem/Solution Overview**

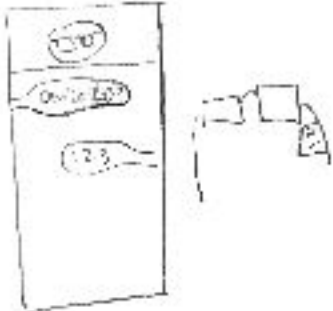
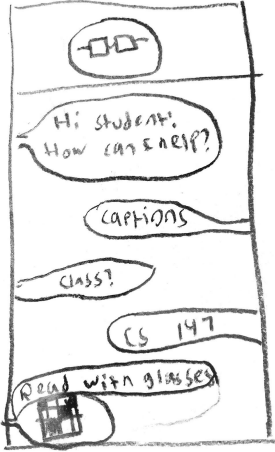
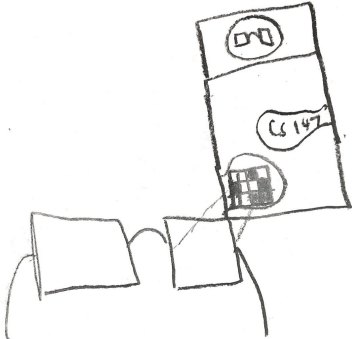
Students who are deaf experience difficulties in lecture. Due to how captions are set up, they must focus on understanding the lecturer's speech instead of learning the material like their peers. Having multiple speakers also confuses students. Our solution provides captioning in students' line-of-sight and shows them who is speaking. We provide captioning and directional visual cues through augmented reality in a head-worn display.

# Sketches

## Initial Designs

We brainstormed 5 different user interface ideas based around providing a better captioning experience.

Sketch #1: The user texts a chatbot to set up and work with the AR glasses.

		
<p>Fig 1: The student texts the device number to a chatbot.</p>	<p>Fig 2: Student asks chatbot for CS 147 captions</p>	<p>Fig 3: A scannable QR code is presented..</p>

Sketch #2: **Gesture-based** user interface with captions on the **phone**.

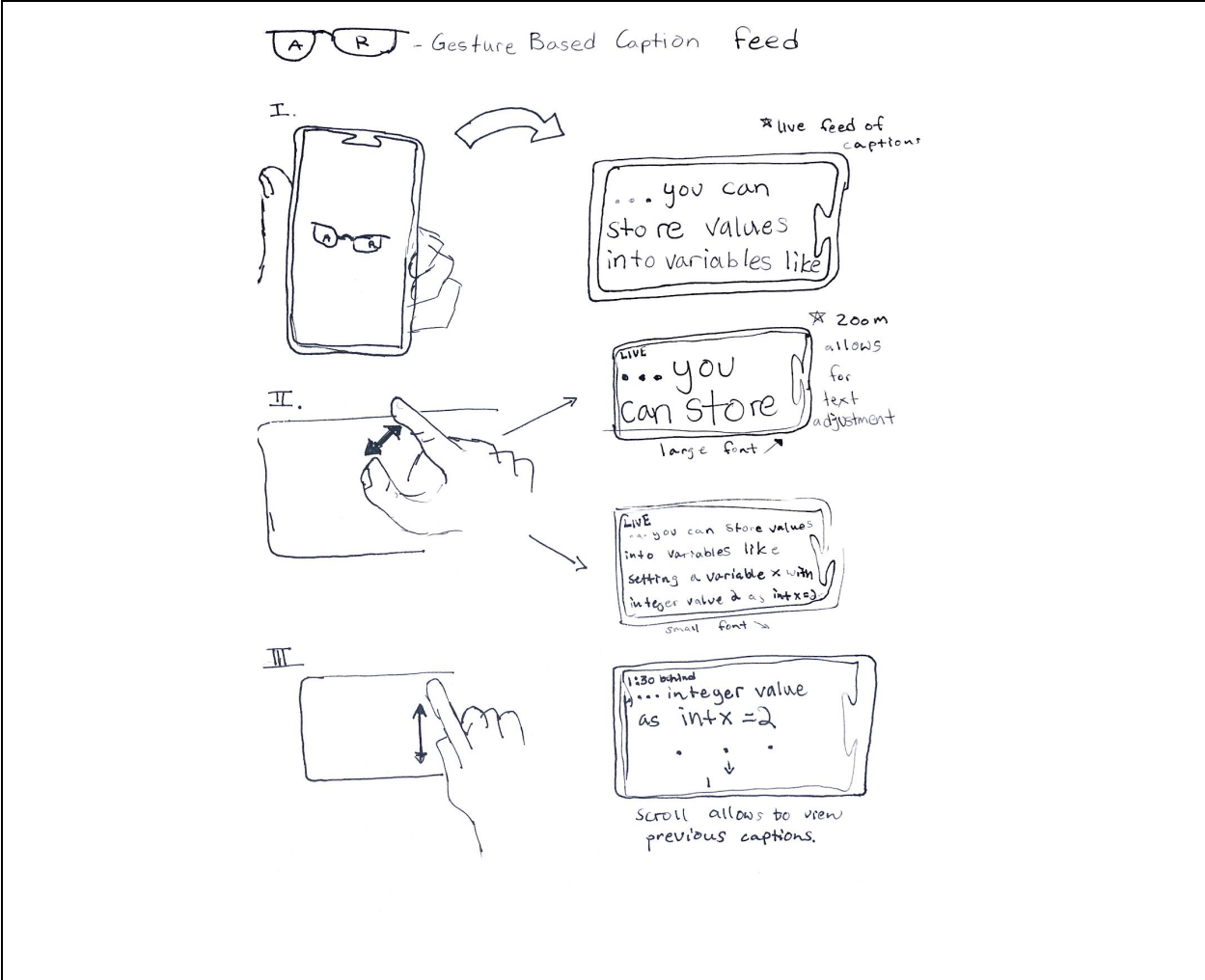


Fig 4: Using gestures to control the captions on a mobile device.

Sketch #3: Captions on the AR glasses and a **mobile application** to interact with the glasses

<p>Fig 5: Glasses loading screen</p>	<p>Fig 6: Captions and speaker identification on the glasses</p>	<p>Fig 7: QR code scanning</p>

*Sketch #4: Frames with **haptic bumps** to orient the user towards speakers.*

<p>Fig 8: Haptic bumps point towards the speaker, plus a novel speaker.</p>	

*Sketch #5: Unique ways to present **real-time captions on any surface** (not AR glasses)*

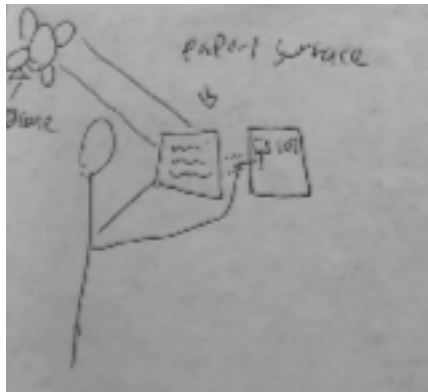


Fig 9: Drone projects captions

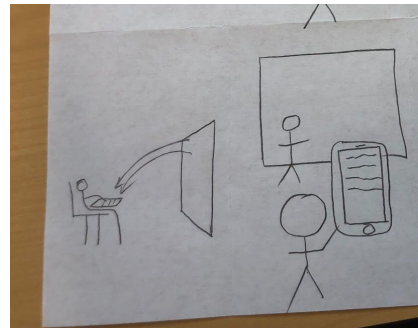
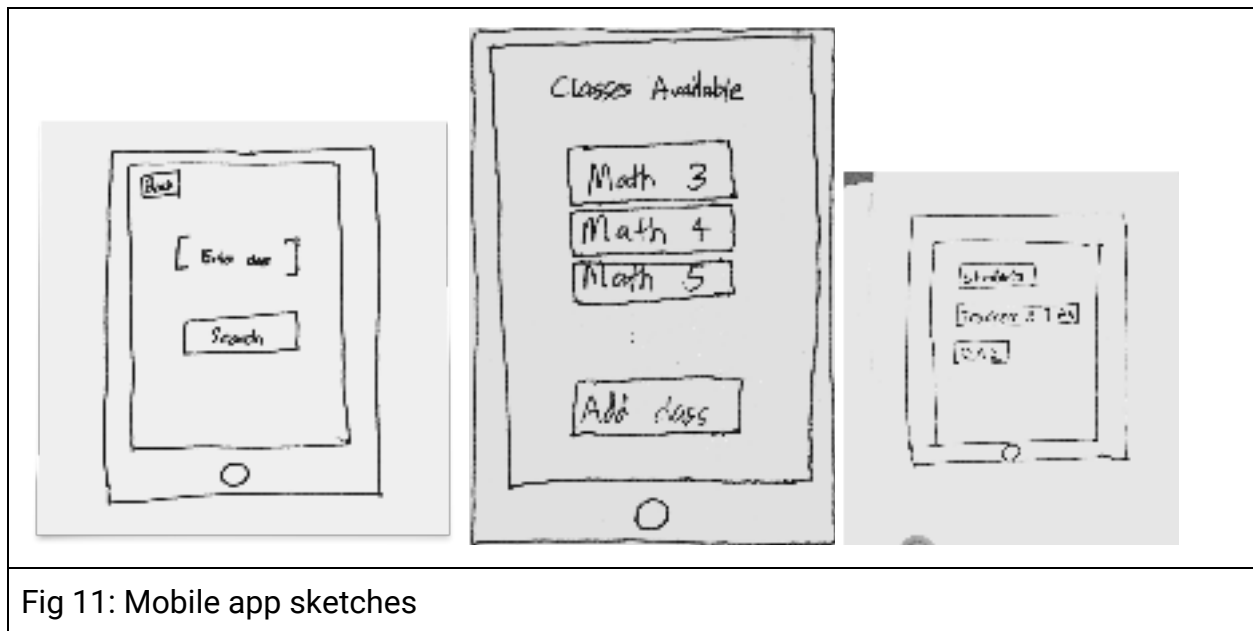


Fig 10: More projections

## Top two designs and storyboards

We decided to focus on our mobile app and chatbot design ideas.

### Mobile App



Pros	Cons
<ol style="list-style-type: none"><li>1. Intuitive to use</li><li>2. Easy to learn</li><li>3. Different account types for different types of users</li></ol>	<ol style="list-style-type: none"><li>1. Have to download an app</li></ol>

## Chatbot

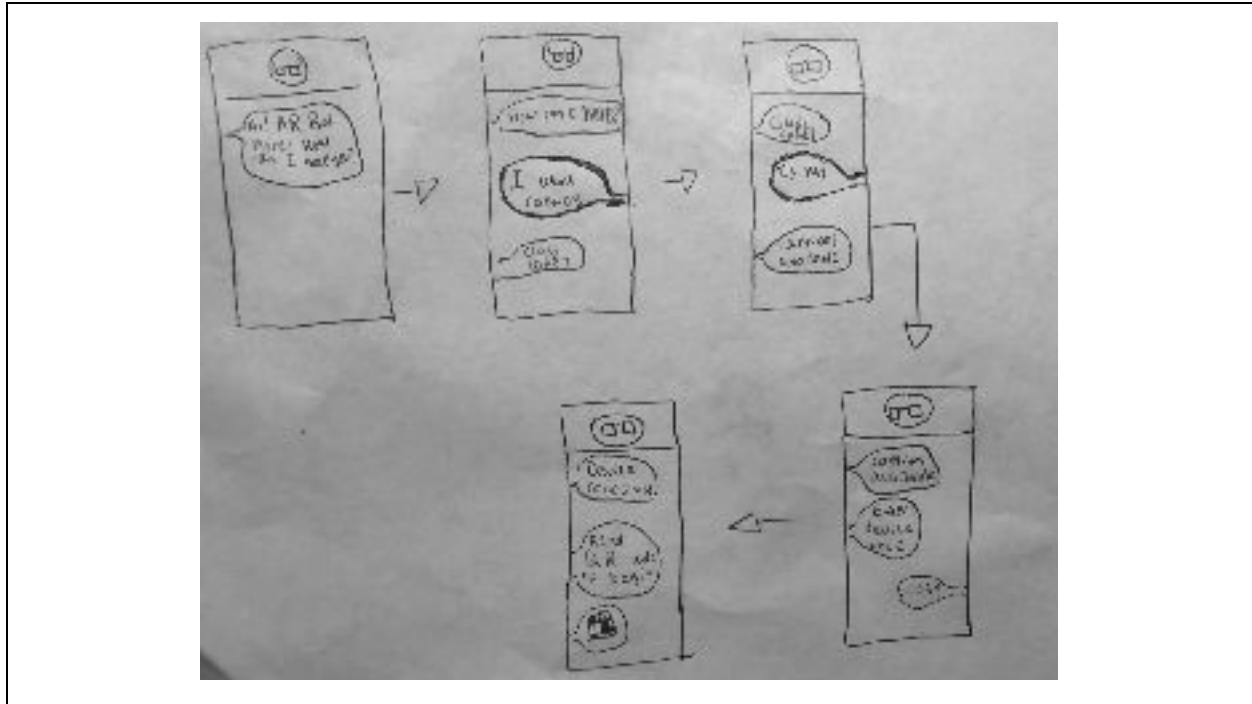


Fig 12: Storyboard of a user choosing a class via chatbot

Pros	Cons
<ol style="list-style-type: none"><li>1. Intuitive to text</li><li>2. Don't have to download an app</li></ol>	<ol style="list-style-type: none"><li>1. Texting is more work than tapping</li><li>2. Lack of clear path forward is frustrating</li><li>3. Financial barrier: SMS charges, data cost</li><li>4. Requires signal</li><li>5. Interviewees complained of missing notifications.</li></ol>

### Selected Interface

We decided to move forward with the mobile app UI. A tap-based mobile app is faster to use and easier to learn than chatbot commands. SMS-based chatbots can also incur text or data charges. Finally, missing notifications was an issue for some of the hard-of-hearing users we spoke with, and a chatbot involves text notifications.



Task 2 (Moderate): Track who is speaking in a room

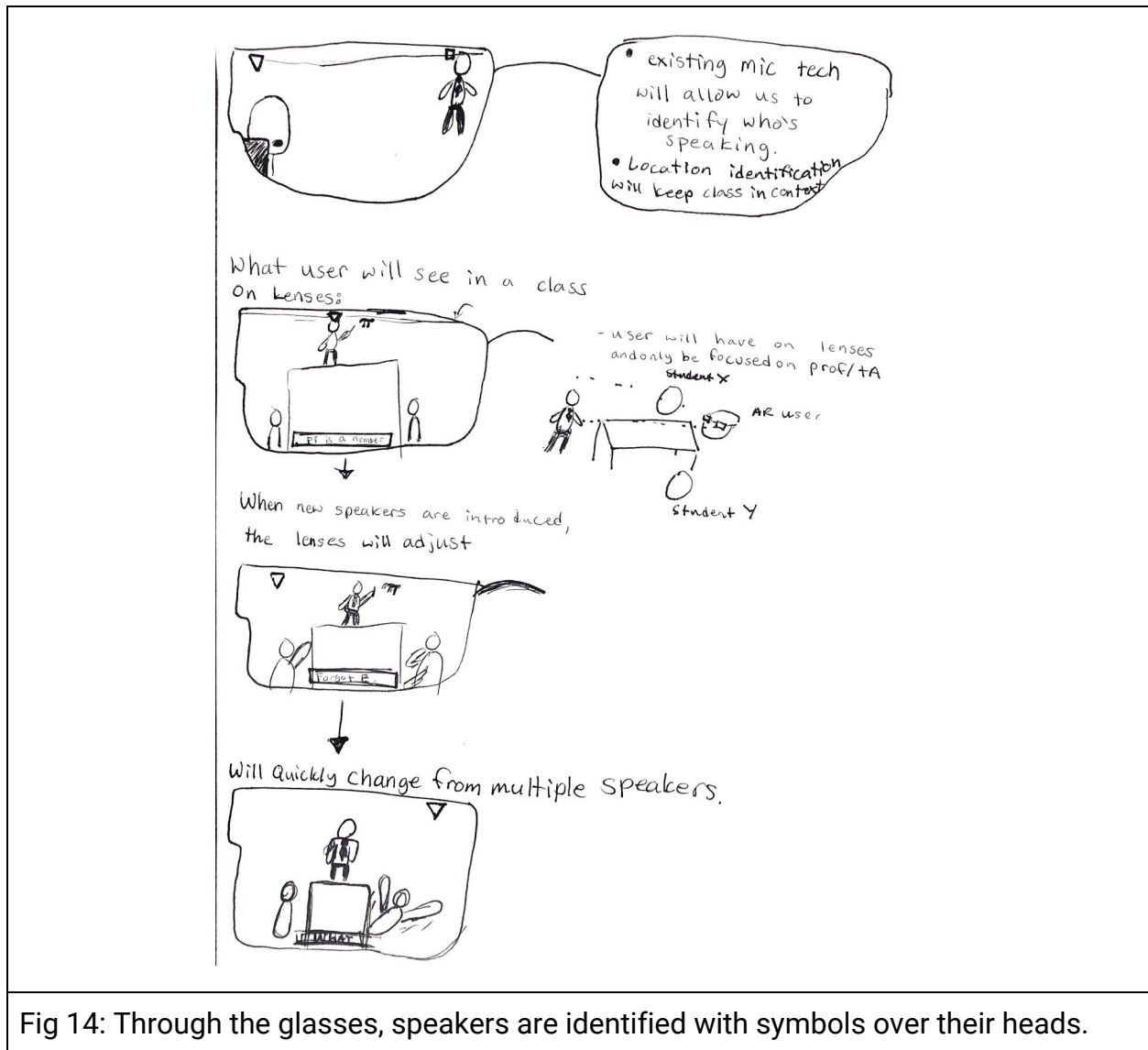


Fig 14: Through the glasses, speakers are identified with symbols over their heads.

Task 3 (Complex): Understand lecture

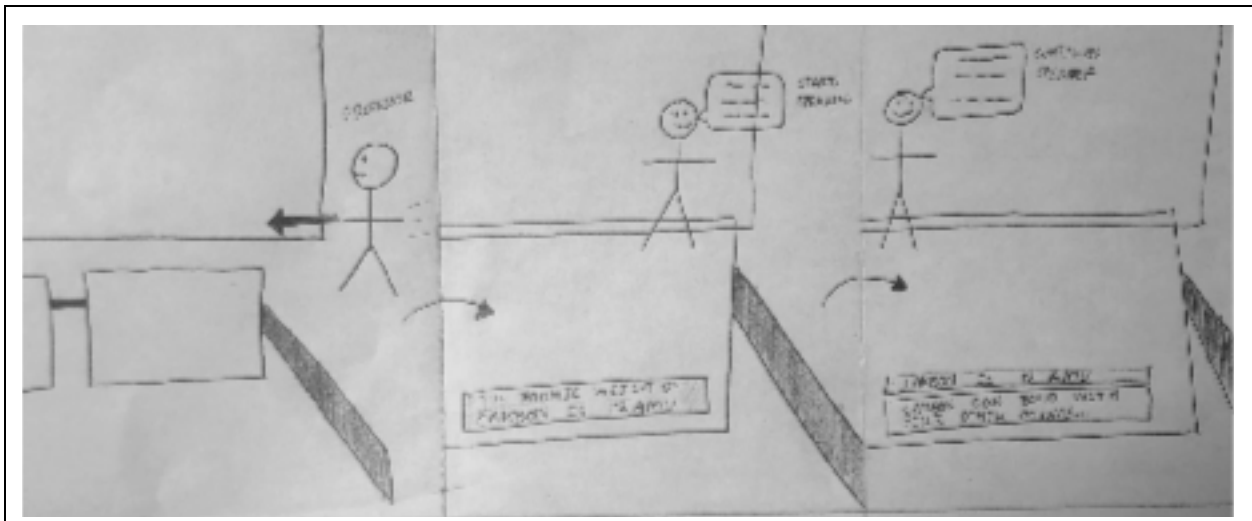
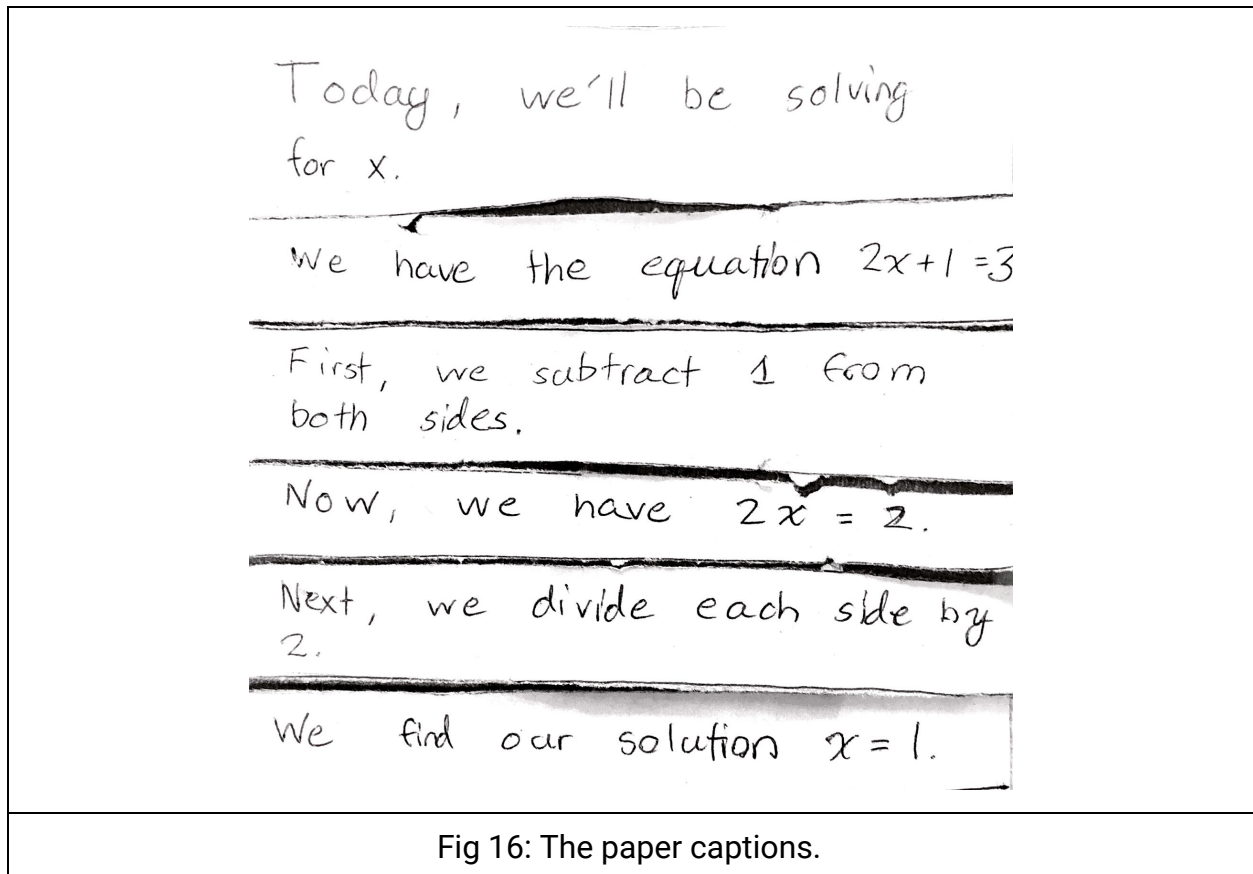


Fig 15: Captions are presented to the user.

## Prototype Description and Images

First is our prototype of captions placed in users' field-of-view using Augmented Reality.



Below, we see the two task flows of our mobile app prototype:

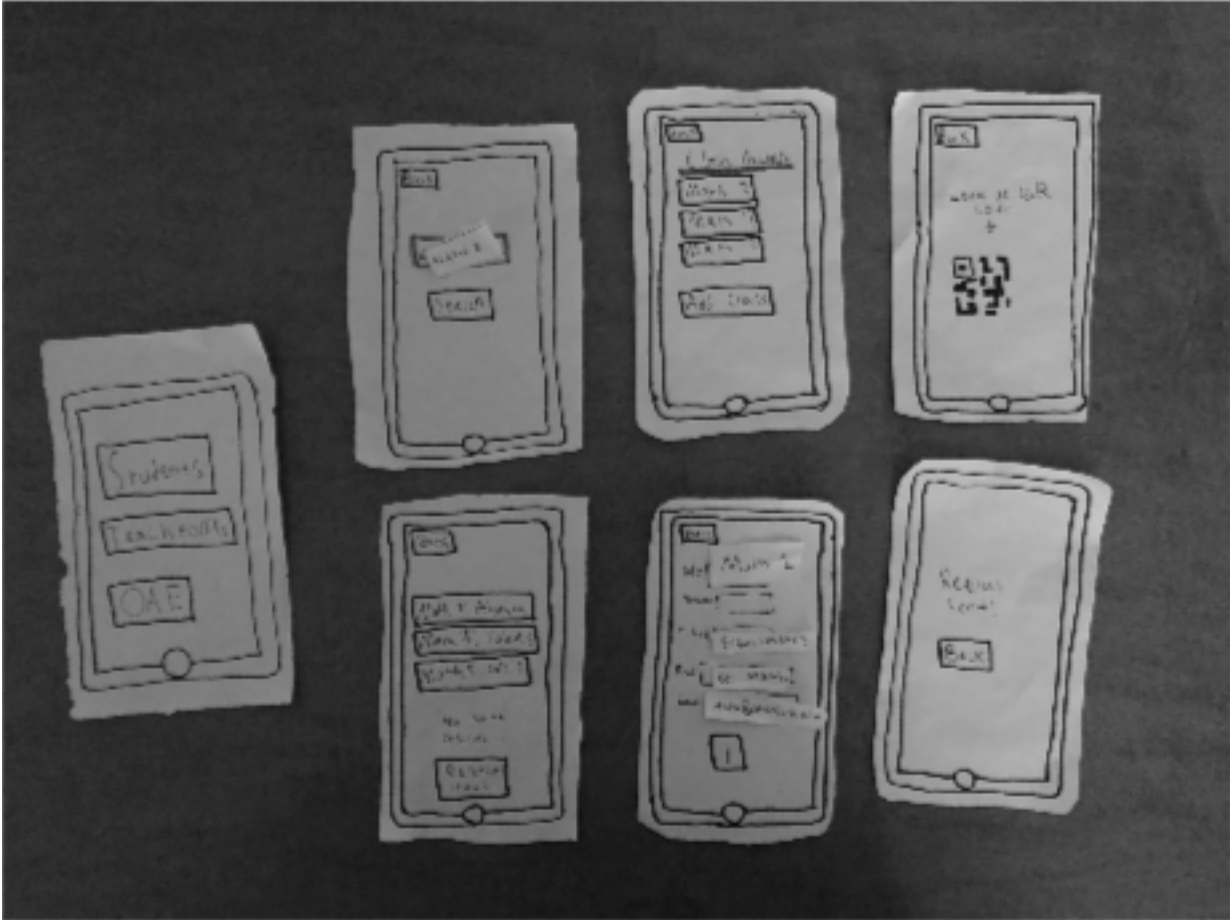


Fig 17: Task flows for the mobile app

Below, we find the paper prototype of the arrow used to indicate the active speaker:

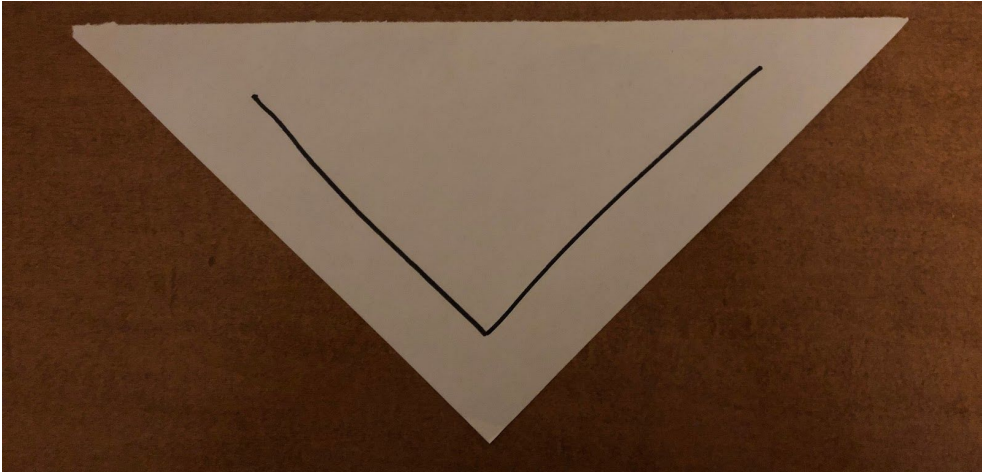


Fig 18: The arrow used to indicate the active speaker in a conversation.

Here we present a prototype that allows students to start captioning for a class that already supports Audio Reality captioning:

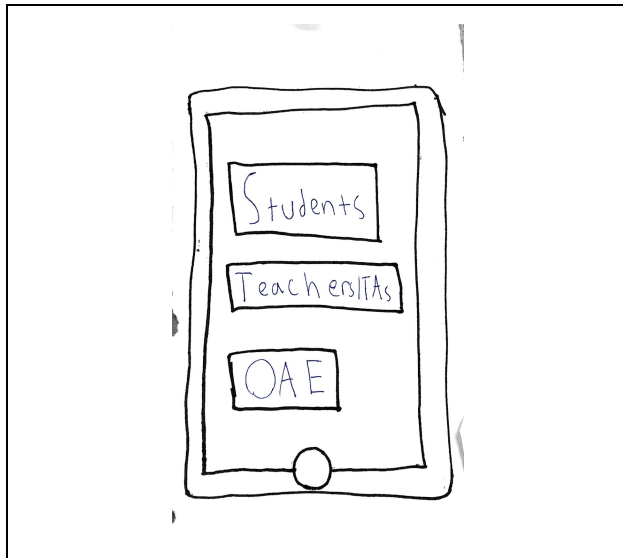


Fig 19: Users tap on the Students tab.

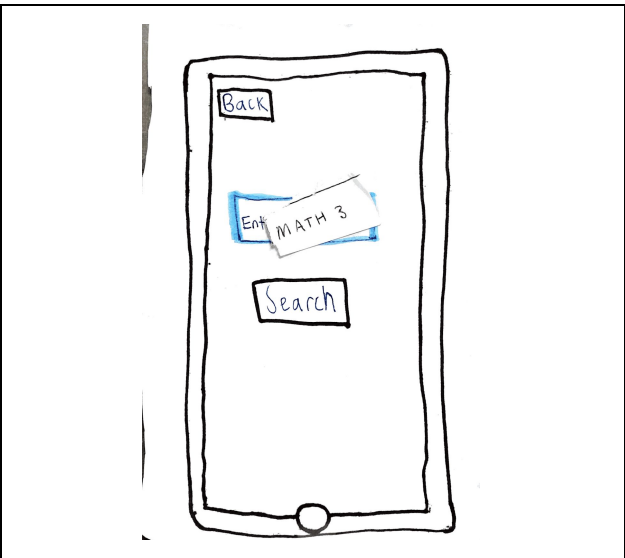


Fig 20: Users enter in "Math 3" and tap "Search" to look up this class.



Fig 21: Users then select a class from the populated results.



Fig 22: User can scan the QR code with the AR glasses.

Finally, we present a paper prototype for Teachers, TAs, and OAE staffers to add a class for Audio Reality support.

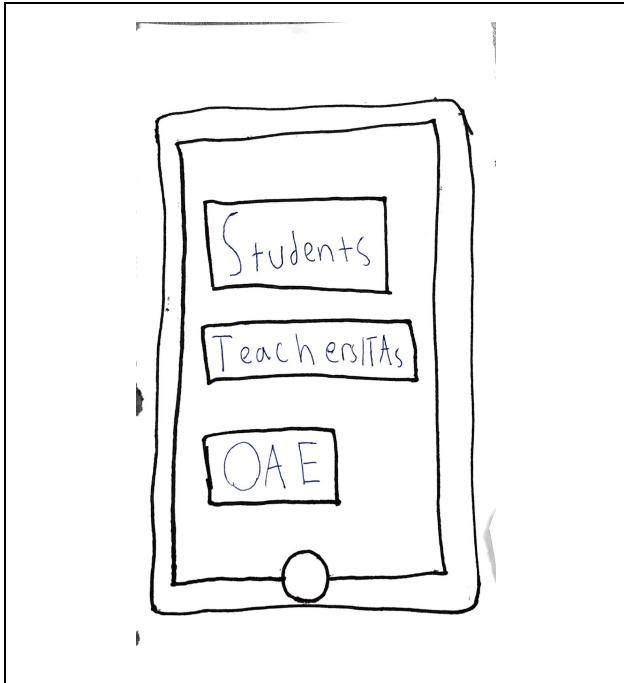


Fig 23: Teachers, TAs, or OAE staffers tap on their respective buttons.

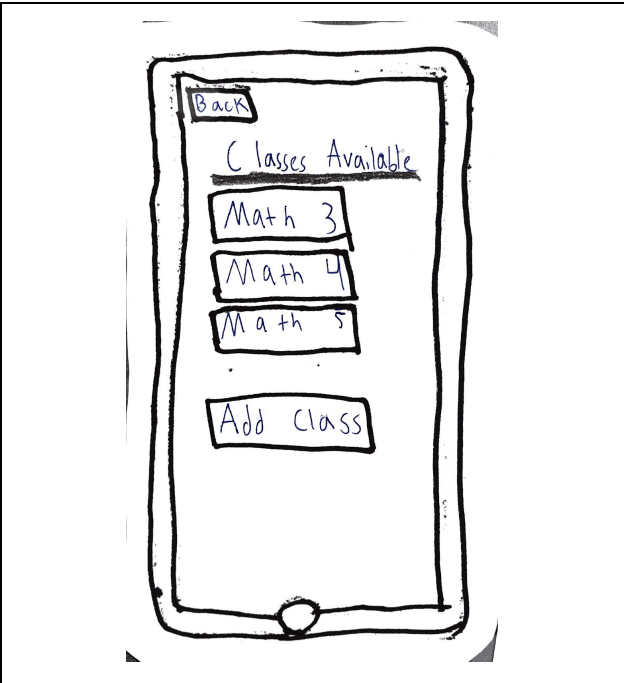


Fig 24: A list of currently-available classes is presented to the user with the option to add a new class.

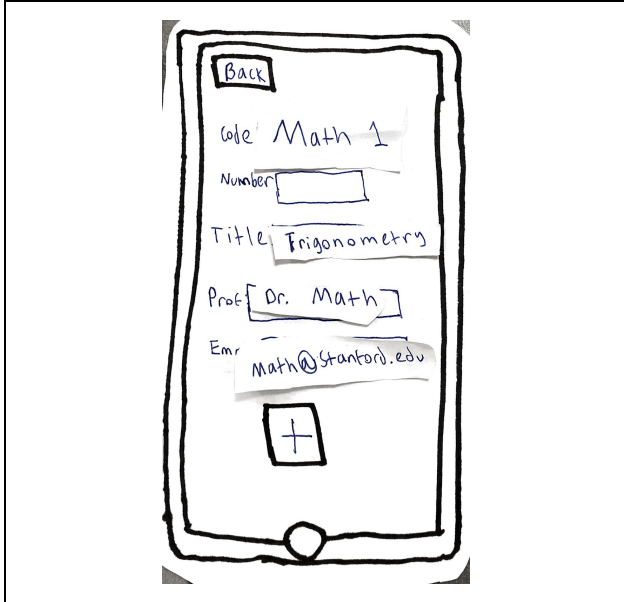


Fig 25: Upon requesting that a new class be added, a form is presented.

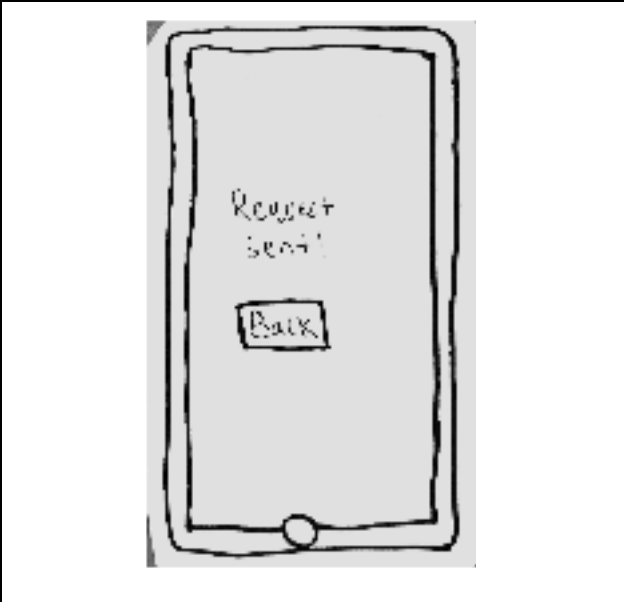


Fig 26: Submission confirmation screen

Key Interaction Ideas	Purpose
-----------------------	---------

App	To select and add classes
Glasses	To display caption (fig 16) and identify speakers
Buttons	Select classes, progress through app
QR codes	Communication between glasses and mobile app (fig 20)

## Method

### Participants

For testing our lo-fi prototypes, we recruited three participants:

<b>Participant Number</b>	<b>Age</b>	<b>Occupation</b>	<b>Gender</b>	<b>Why were they recruited?</b>	<b>Environment</b>
1	Mid-30s	Disabilities coordinator at the Office of Accessible Education (OAE)	Female	Our application requires interaction with the OAE. We thought it best to test our prototype with a member of this office.	OAE office
2	Mid-80s	Retired	Female	We spoke to a user who didn't have experience with AR glasses to simulate how a new student might respond to the experience for the first time.	Outside the offices of the Pacific Hearing Service in Menlo Park, CA
3	Mid-20s	TA	Male	One of our target user groups is TAs.	Computer cluster of student's dorm

The first two participants were not compensated, but the last received cookies.

## Tasks

Participants were asked to complete three different tasks with three different lo-fi paper prototypes:

1. Simple: Understand what's being said in lecture
2. Moderate: Identify and find the speaker
3. Complex: Make sure captioning is available for the class

## Procedure

*Task #1 (simple): Understand what's being said in lecture*

We gave a brief math lecture where we solved for  $x$  in the algebraic expression  $2x + 1 = 3$ . We followed the script below:

1. "Today, we'll be solving for  $x$ ."
2. "We have the equation  $2x + 1 = 3$ ."
3. "First, we subtract 1 from both sides"
4. "Now we have  $2x = 2$ "
5. "Next, we divide each side by 2"
6. "We find our solution  $x = 1$ "

As each line of the script was said by the lecturer, a second team member placed a paper text caption in the participant's field-of-view.

*Task #2 (moderate): Identify and find the speaker*

Two team members had a conversation in front of the participant. A third team member placed a paper arrow behind the active speaker in the conversation.

*Task #3 (complex): Make sure captioning is available for the class*

We presented paper prototypes of our mobile app screens to the participant. We challenged the participants to complete two tasks:

1. "As a student, can you find the Math 3 class?"
2. "As an OAE representative (or Course Assistant), can you create a new class to support Audio Reality captioning?"

One team member acted as the "application" and presented the correct screen to the participant as they interacted with the paper prototypes.

## Test Measures

We wanted to observe and interpret emotional reactions to our prototype to see where people enjoyed using our project and where they became confused or irritated. Points of confusion will be re-designed to provide a better user experience.

The incident logs for each participant can be found in the [Appendix](#).

## Team Member Roles

<b><i>Participant Number</i></b>	<b>Task #1: Understand what's being said in lecture</b>	<b>Task #2: Identify and find the speaker</b>	<b>Task #3: Make sure captioning is available for the class</b>
1	Lecturer: Pramod "Application": Manny	Student 1: Pramod Student 2: Kylie Lecturer: Pramod "Application": Manny	"Application": Manny
2	Lecturer: Pramod "Application": Manny	Tester asked to leave	"Application": Manny
3	Lecturer: Pramod "Application": Kylie	Tester had to leave	"Application": Kylie

## Results and Discussion

Our mobile app had a few issues. For the most part, users completed the tasks quickly and easily.

One user told us that the form to request a class was unnecessarily long and complicated. She said that the OAE office used a Stanford-wide lookup function that gave them all of a class's information with just the course code or number. This finding will inform future iterations of the prototype.

Two of the users had no issues with the captions. The third user had never used/seen video of AR glasses before and had issues conceptualizing the captioning experience. This encounter made us realize that the concept of AR glasses is not as intuitive as we thought. We will keep in mind the need for clear onboarding explanations for the AR glasses, likely via diagrams/videos in the app.

The OAE accessibility coordinator noted that students often complain about having to switch between the tablet and the whiteboard. She said that with the glasses, students could focus on both the captions and the whiteboard. Her comments on our choice of the AR smart glasses form factor are confirmation that we are working in the right direction.

Finally, when we were testing the speaker identification feature, the user could point to the person being identified by the triangle. However, the user said that in a larger room with many people talking, this feature would not be useful. She recommended having the arrow positioned in front of the user, pointing to the nearest or loudest voice instead of over the user like we had originally intended. We will change that feature going forward.

**Word count: 1490**

## Appendix

### Critical incident logs

Participant 1: OAE disability coordinator

Incident	Severity
<i>Task: Choosing a class</i>	
Confused as to what class she is searching for (-)	2
Tapped on the course name input field as desired (+)	0
Nods and understands that she must tap on the UI buttons to progress to new screens (+)	0
Understands that the QR code must be scanned by the smart glasses (+)	0
<i>Task: Adding a new class</i>	
Confused as to the difference between the course name (i.e. "Math 1") and course number (i.e. "123")	3
<i>Task: Understanding what's being said in lecture</i>	
Nods and understands that the captions presented to her are for the lecture (+)	0
Comments that having captioning in her line-of-sight is invaluable for understanding lecture content	0
# of negative emotional moments/errors: <b>2</b>	# of positive emotional moments/successes: <b>5</b>

Participant 2: Senior citizen with severe hearing loss

Incident	Severity
<i>Task: Choosing a class</i>	
Confused as to what OAE stands for	4
Expressed doubt as to why she needs to select a class at all	3
<i>Task: Adding a new class</i>	
Confused as to why she needs to add a new class to the system	3
Did not understand which paper text "input" matched to which fields	2
<i>Task: Understanding what's being said in lecture</i>	
Noted that having captioning under the lecture board would be invaluable	0
Confused as to what "augmented reality" and "head-worn displays" are all about	0
# of negative emotional moments/errors: <b>4</b>	# of positive emotional moments/successes: <b>2</b>

Participant 3: Course Assistant

<b>Incident</b>	<b>Severity</b>
<i>Task: Choosing a class</i>	
Nodded when he saw the home screen (+)	0
Tried to click the text entry space (-)	3
Put the math 1 request in, but didn't click anything (-)	2
Paused and cocked head once he got to the QR code	1
Shrugged before looking at the code	0
<i>Task: Requesting a class (as a TA)</i>	
Finger hovered before selecting Prof/TA	1
Nodded when the class request form came up (+)	0
Signed unhappily when filling out the class request form (-)	3
<i>Task: Identifying speakers</i>	
Nodded when the triangle moved	0
<i>Task: Understanding lecture (with captions)</i>	
Leaned towards the captions (to focus better on them) (+)	2
Looked between the board and the captions	0
Nodded along with the lecturer (+)	0
<b># of negative emotional moments/errors: 3</b>	<b># of positive emotional moments/successes: 4</b>