**Tools and Technologies to Solve the Problem**

The platform is designed to provide an inclusive learning experience for differently-abled students by integrating AI, machine learning, and assistive technologies. The following technologies are utilized:

**1. AI/ML Stack**

These technologies enable accessibility features through artificial intelligence and machine learning:

* **TensorFlow Lite** → Used for Sign Language Recognition, Sign-to-Text, and Text-to-Sign conversion.
* **Google ML Kit** → Facilitates handwriting recognition for the writing pad.

**2. Third-Party APIs**

External APIs that power assistive technologies:

* **Google TalkBack** → Provides screen readers for blind students.
* **Liblouis** → Converts digital books into Braille.
* **Google Text-to-Speech (TTS)** → Enables audio-based learning for visually impaired students.
* **Google Speech-to-Text API** → Generates captions for audio and video, aiding deaf students.
* **Spotify API** → Supports music therapy and AI-driven music recommendations.

**3. Database System**

Manages user progress, tracking, and exam-related data:

* **Firebase Firestore** → Stores:
  + Real-time progress tracking for all student categories.
  + Exam section data for all student categories.
  + Reward-based motivation tracking.

**4. Backend Processing Workflows**

**1. TensorFlow Lite (Sign Language Recognition)**

**Backend Flow:**

* Captures hand gestures via a webcam or mobile camera.
* Preprocesses images by applying grayscale conversion and noise reduction.
* Detects fingers and palms using a trained TensorFlow Lite model.
* Extracts keypoints from detected hand landmarks.
* Matches features with a predefined sign language dataset.
* Converts recognized gestures into corresponding text.

**2. Text-to-Sign Model (Sign Avatar Generator)**

**Backend Flow:**

* Accepts text input from users.
* Uses NLP to break the text into words and phrases.
* Maps words/phrases to corresponding sign language gestures.
* Uses a 3D animation engine to render sign gestures in real-time.

**3. Google ML Kit (Handwriting Recognition)**

**Backend Flow:**

* Captures handwriting input via touch screen, stylus, or scanned images.
* Preprocesses by removing noise and enhancing contrast.
* Segments words into individual characters.
* Extracts handwriting features and matches them with a trained model.
* Converts handwritten text into machine-readable format.

**5. Assistive Technologies for Accessibility**

* **Google TalkBack** → Detects user interaction and provides voice feedback for UI elements.
* **Liblouis** → Processes text into Braille format for visually impaired students.
* **Google TTS** → Converts text into audio speech with phonetic and prosody adjustments.
* **Google Speech-to-Text API** → Captures audio input and generates real-time captions.