Interactive System For Teaching Telugu Alphabets

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Abstract- This paper presents the design and development of an interactive educational system aimed at teaching the Telugu language alphabet to children aged 3–5 years. The system employs a multi-sensory learning approach, integrating visual, auditory, and kinaesthetic elements to enhance letter recognition and writing skills. The frontend is implemented using Next.js to provide a fast and responsive user interface. The system displays Telugu letters along with visual tracing guides that include dotted lines and directional arrows to indicate the correct stroke order. Additionally, an integrated audio feature plays the pronunciation of each displayed letter to reinforce phonetic learning.

The backend is designed to store and manage user progress, ensuring efficient tracking of children's learning journeys. A Convolutional Neural Network (CNN) model is integrated to analyze children's traced letters, evaluating handwriting accuracy and identifying areas requiring improvement. By integrating the CNN model with a login/signup system for progress tracking, we analyze a child's learning curve and identify difficult alphabets.

The system design emphasizes child-friendly principles by ensuring simplicity, engagement, and accessibility. Preliminary evaluations suggest that the proposed system effectively enhances early literacy development by making the learning process intuitive, interactive, and enjoyable for young learners.

Keywords—Telugu language, Alphabet learning, Next.js, PostgreSQL, SQLite, Convolutional Neural Network (CNN), Child-friendly design, Interactive education.

I. INTRODUCTION

Learning Indian alphabets at an early age is essential as it forms the foundation for literacy, cognitive development, and cultural identity. Many Indian languages have unique scripts, and early exposure helps children develop reading and writing skills more effectively. However, traditional teaching methods often rely on rote memorization, which can be disengaging and ineffective. The complex strokes of scripts like Telugu make it difficult for young children to write letters accurately, especially when their fine motor skills are still developing. Additionally, the lack of personalized learning and real-time feedback in traditional classrooms means children struggle with letter formation without immediate correction. Many parents also face challenges in guiding their children due to time constraints or lack of effective teaching strategies.

Technology can address these challenges by making alphabet learning interactive and engaging. Digital learning tools with touch-based tracing, animations, and gamification can capture children's attention while reinforcing correct writing techniques. A multisensory approach—including visual demonstrations, auditory pronunciation guidance, and kinesthetic tracing—enhances learning retention. AI-driven handwriting recognition can provide real-time feedback, highlighting errors and guiding proper stroke formation. Progress tracking features allow parents to monitor their child's development and encourage active participation. Additionally, multilingual support can help children learn multiple Indian scripts simultaneously, fostering linguistic skills and preserving cultural heritage. By integrating these modern educational techniques, technology makes learning Indian alphabets more effective, personalized, and enjoyable for young learners.

II. IMPLEMENTATION

A. Tools And Software Used

Tool / Software	Purpose	Justification
Next.js	Frontend Development	Offers fast rendering, built-in routing, and enhanced SEO support.
Tailwind CSS	Styling Framework	Provides a utility-first approach that simplifies design and ensures responsiveness.
SVG (Scalable Vector Graphics)	Interactive Letter Tracing	Ensures clean rendering of complex letter shapes and allows animation for tracing paths.
React Hooks	State Management	Manages state efficiently for dynamic UI updates and tracing accuracy.
CNN	Handwriting Recognition	Evaluates children's traced letters for accuracy and identifies areas requiring improvement.
PostgreSQL & SQLite	User Progress Tracking	Efficiently stores and manages login/signup data to track individual learning progress.

B. Key Features of the System

1. Interactive Letter Display: Each Telugu alphabet is displayed prominently with a corresponding pronunciation button.
2. Guided Tracing Interface: SVG-based letters include dotted paths and directional arrows to assist stroke order.
3. Feedback System: Real-time feedback ensures children receive visual cues like color changes for correct tracing.
4. Audio Assistance: Integrated audio pronunciation guides help improve phonetic learning.
5. Multisensory Learning: Combines visual guidance, sound effects, and touch interaction to create an immersive learning experience.
6. User Authentication & Progress Tracking: A login/signup system enables personalized learning, allowing children to save progress and revisit difficult alphabets.

7. Database Management: User data, learning progress, and handwriting evaluations are securely stored using PostgreSQL/SQLite for efficient tracking.
8. Handwriting Recognition (CNN Integration): The backend processes handwriting input using a Convolutional Neural Network (CNN) to assess accuracy and provide corrective feedback.

c.Step-by-Step Implementation process

1. Frontend Development:
   - Developed using Next.js with a component-based architecture for improved modularity.
   - Letter cards were built to dynamically render individual alphabets, ensuring scalability for future language expansion.
2. SVG Path Design:
   - Telugu letters were converted into SVG format to create scalable, interactive paths.
   - Each SVG path was enhanced with dotted guidelines, directional arrows, and animated sequences for accurate tracing.
3. State Management with React Hooks:
   - useState was utilized to track user-selected letters and tracing progress.
   - useEffect managed dynamic animation triggers and visual updates.
   - useRef controlled SVG path manipulations for precise tracing movements.
4. Backend Development & User Authentication:
   - Implemented a login/signup system to enable personalized learning and track individual progress.
   - User authentication ensures that each child's learning journey is saved for future sessions.
   - PostgreSQL/SQLite databases store user profiles, progress history, and handwriting accuracy data.
5. Handwriting Recognition using CNN:
   - Integrated a Convolutional Neural Network (CNN) to evaluate children's traced letters for accuracy.
   - The model provides real-time feedback, identifying weak alphabets and suggesting targeted practice.
6. Styling with Tailwind CSS:
   - Utilized Tailwind's utility classes to design a vibrant, engaging interface with child-friendly colors and large touch areas.
   - Emphasis was placed on simplicity to ensure navigation was intuitive for young learners.
7. Deployment and Hosting:
   - The frontend was deployed using Vercel, ensuring fast delivery and reliable uptime.
   - The backend, including the database and authentication system, was hosted to ensure efficient data management and scalability.
   - Ensured flexibility for future updates, allowing additional alphabets and features to be incorporated seamlessly.

III. Demonstration of Working Model

A. Working Model Overview

- A welcome page with ”Start Learning” button which redirects to home page

Fig 1

- Upon accessing login button, users should give their credentials to login .

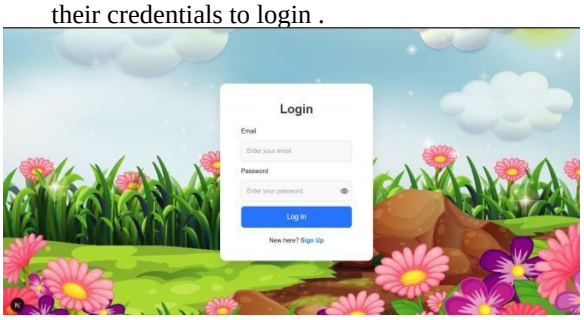

Fig 2

- If user is new they have to create a account using signup page.

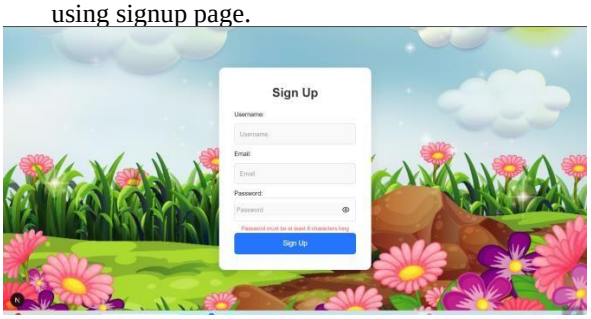

Fig 3

- After successful login, users encounter an engaging menu for alphabet selection.

Fig-4

- Selecting a letter opens an interactive interface displaying the letter's SVG path with guided tracing instructions.

Fig-5

- Children trace the letter using touch or mouse input, with real-time visual cues indicating accuracy.

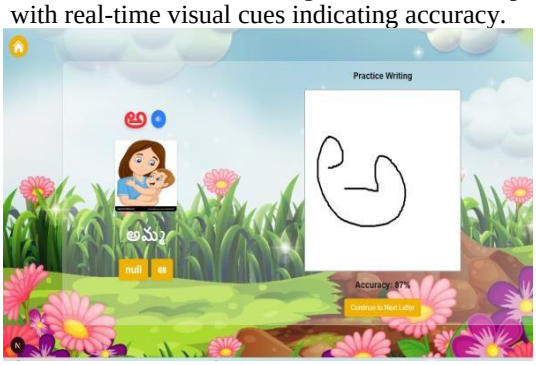

Fig 6

- *After successful submission, progress tracking is updated on the home page by awarding stars based on the student's performance, and the subsequent alphabets will remain locked until the required progress is achieved.*

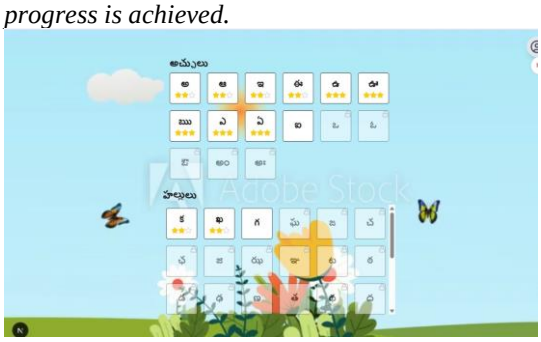

Fig 7

B. Key Interaction Flow

- Complete login process
- Go to Home page
- Select a letter from the menu.
- Observe the displayed letter demonstration
- Follow the animated path to trace the letter.
- Try to write in a blank space provided.
- After submission accuracy will provided.
- Go to next page to learn more.

IV. Analysis of Technique Used to Find Learnability

A. The techniques implemented in the system provide a structured and effective approach to assessing a child's ability to learn alphabets. The integration of a Convolutional Neural Network (CNN) plays a crucial role in analyzing handwritten letters, offering an objective accuracy score that reduces human bias and enhances assessment reliability. By evaluating traced letters, the system identifies patterns in mistakes and areas that require improvement.

B. The login/signup system ensures personalized learning by tracking each child's progress over time. This allows the system to identify which letters a child struggles with, enabling targeted reinforcement through repeated practice exercises. Additionally, the use of AI-driven difficulty mapping helps in dynamically adjusting learning content based on individual performance, making the process adaptive and tailored to each child's needs.

C. The interactive feedback mechanism further enhances engagement by providing real-time visual and auditory guidance, improving retention and motivation. The combined approach of CNN-based handwriting analysis, progress tracking, and interactive feedback makes the system an effective tool for early alphabet learning, fostering a more engaging and personalized educational experience.

D. Each technique contributes uniquely to evaluating learnability:

- CNN provides an objective accuracy measurement, reducing human bias.
- The login/signup system personalizes learning and ensures continuity.
- Interactive feedback enhances engagement and retention.
- Difficulty mapping ensures targeted learning, improving efficiency.

V. Comparision of Proposed System with Existing Alphabet Learning Platforms

Feature	Our System	Other Platforms
Tracking Method	User progress stored via FastAPI & PostgreSQL	AI-driven adaptive tracking
Assessment	Accuracy feedback for written letters	AI-based quizzes, pronunciation checks
Engagement	Background videos, letter audio, word-image association	Gamification, streaks, leaderboards
Feedback Mechanism	Accuracy evaluation of letter writing	AI-generated hints, speech analysis
Accuracy Calculation	Uses CNN (Convolutional Neural Network) for handwriting recognition	Machine learning for speech and text accuracy
Persistence	PostgreSQL for user tracking	Cloud-based adaptive learning

Our Telugu alphabet learning system takes a structured, interactive, and technology-driven approach to enhance learnability. It differs from other platforms in various aspects, including tracking methods, assessment techniques, engagement features, feedback mechanisms, and persistence. Below is a detailed comparison of how our system stands out compared to other state-of-the-art learning platforms.

1. Tracking Method

Our system uses FastAPI and PostgreSQL to track each user's progress individually. When a learner completes a letter and moves to the next, the progress is stored in the database. This ensures that users can resume learning from where they left off, even after logging out.

In contrast, many modern language-learning platforms utilize AI-driven adaptive tracking. These platforms monitor user interactions and adjust the difficulty level dynamically. While this approach personalizes the learning experience, it may not always ensure step-by-step mastery of the script, which is crucial for learning a new writing system like Telugu.

2. Assessment Techniques

We provide a real-time accuracy evaluation for written letters, allowing users to see how well they have formed each character. This assessment is based on a Convolutional Neural Network (CNN), which compares the user's handwritten letter with the correct form and provides feedback.

Other platforms generally focus on quizzes and pronunciation assessments rather than handwriting evaluation. For example, many language-learning apps check whether a user correctly selects or types a letter but do not assess the accuracy of handwritten input. Some advanced platforms offer speech recognition for pronunciation, but they lack handwriting analysis for script-based languages.

3. Engagement Features

To make learning more interactive and engaging, our system incorporates multiple multimedia elements, including:

- Background videos to maintain user interest and immersion.
- Audio for each letter to aid in pronunciation and auditory learning.
- A corresponding word and image for each letter, helping users associate letters with real-world meanings and visuals.

In comparison, many other learning platforms focus on gamification techniques such as:

- Streaks (encouraging daily learning habits).
- Leaderboards (ranking users based on performance).
- Badges and rewards (motivating continued progress).

While gamification boosts motivation, our approach emphasizes multisensory learning (visual, auditory, and kinesthetic), making it particularly effective for young learners or beginners.

VI. SYSTEM FEATURES

The system consists of the following key components:

A. Authentication and Session Management

1.Login and Signup: Secure user authentication to personalize progress tracking.

2.Logout: Ensures session security and user data protection.

B. Learning and Interaction

3.Letter Display & Drawing Area:

- The alphabet appears on one side of the screen.
- The child traces the letter in the adjacent drawing area using a finger or stylus.

4.Accuracy Calculation:

- Compares the traced letter with the original shape.
- Displays a percentage score to indicate how accurately the child traced the letter.

5.Progress Tracking:

Successfully completed letters are marked with different number of stars..

Helps children and parents track progress systematically.

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VII. CREATIVITY IN INPUT/OUTPUT DEVICES USED

The system incorporates innovative input and output devices to maximize engagement and usability for young learners.

A. Input Devices:

1. Touchscreen Interface

- The system is designed for touch-based interaction, allowing children to trace letters directly using fingers or a stylus.
- This input method makes the interaction intuitive and accessible, as children in this age group are naturally familiar with touch gestures from smartphones and tablets.
- The system registers finger movements and translates them into digital strokes, providing a realistic writing experience.

2. Stylus/Pen Input

- The use of a stylus mimics real-life handwriting, making the transition to paper-based writing smoother.
- Benefits of stylus input include:
- Improved fine motor skills: Helps children learn grip control and hand stability, crucial for future handwriting skills.
- Precision in letter tracing: More accurate than finger tracing, allowing better shape formation.
- Simulates traditional writing: Bridges the gap between digital and physical learning experiences.

B. Output Devices

1. Interactive Display

The system includes a high-resolution, touch-enabled display that visually guides the child through the tracing process. It

provides real-time visual feedback, including:
Animations: Color changes, sparkles, or glowing effects appear as the child traces correctly.

- Progress Indicators: A stroke turns green when correct and red when incorrect.
- Encouragement Graphics: Smiley faces, stars, or confetti appear upon successful tracing.

2. Haptic Feedback

Haptic feedback (vibration-based response) is used to provide touch-based reinforcement.

- When a child makes a mistake (e.g., tracing outside the guided lines), the system shows the word in red color as a warning.

How It Helps:

- Alerts the child without using negative audio cues, ensuring a positive learning experience.
- Provides sensory reinforcement, improving letter shape memory.

3. Audio Feedback

The system includes voice-based feedback to enhance phonetic learning.
Types of Audio Feedback:
Letter Pronunciation:

- The system pronounces the letter aloud (e.g., "అ").
- Helps children associate visual letters with their sounds, improving phonemic awareness.

Encouragement Phrases:
Positive reinforcement phrases include:

- "Great job!" (for correct tracing)
- "Try again!" (for incorrect tracing)
- "You're getting better!" (for progress tracking)
- Keeps children motivated and engaged.

4. Guided Instructions:

- If a child struggles, the system provides step-by-step audio guidance on how to trace correctly.
- Example: "Provide guided tracing with the stroke to draw correctly."
- This structured output ensures real-time feedback and a positive learning experience, making alphabet tracing interactive, engaging, and effective for young learners.

VIII. Analysis of Learnability

The learnability of the system determines how quickly a child can grasp and adapt to its interface. The design integrates cognitive science principles to ensure effortless learning, making the process engaging and intuitive for young users.

A. Factors Enhancing Learnability

1. Simple UI Design:
   - Large, colorful letters improve visibility and keep children engaged.
   - Minimal distractions help maintain focus on learning, reducing cognitive overload.
2. Immediate Feedback:
   - Provides real-time corrections, allowing children to identify mistakes quickly and learn from them.
   - Reinforces correct writing patterns by encouraging repeated practice with guided tracing.
3. Progress Visualization:
   - Tick marks and reward-based motivation (e.g., stars, badges) encourage children to complete all letters.
   - Supports self-paced learning, allowing each child to progress at their own speed.
4. Reinforcement through Multi-Sensory Input:
   - Audio cues strengthen letter recognition by associating visual symbols with sounds.
   - Haptic feedback enhances writing accuracy through tactile reinforcement, improving muscle memory.

B. Expected Learning Outcomes

1. Improved Hand-Eye Coordination:
   - Tracing letters helps develop fine motor skills and improves visual-motor integration.
2. Better Alphabet Recognition and Recall:
   - Repetitive interaction with letters ensures long-term retention and recognition.
3. Fine Motor Skill Development:
   - Tracing with a stylus or finger enhances pen control and refines handwriting skills.

By applying these user experience and learning design principles, the system ensures that children find the learning process intuitive, enjoyable, and rewarding while gradually improving their writing proficiency.

IX . Conclusion

The Indian Language Alphabet Learning System provides an interactive, child-friendly, and effective platform for young learners to master the Telugu alphabet. By leveraging touchscreen technology, stylus input, and real-time feedback mechanisms, the system ensures an engaging and multi-sensory learning experience.The integration of audio guidance, progress tracking, and gamified elements enhances motivation and retention, making the learning process enjoyable. The system not only fosters early literacy skills but also supports cognitive and motor development, helping children build a strong foundation for future language proficiency.

Future enhancements may include expanding the language database, incorporating gamification elements such as leaderboards and achievement badges, and personalized learning pathways to adapt to each child's pace. By continuously improving user experience and engagement, this system has the potential to revolutionize early alphabet learning and literacy education.

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