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PP 43– 61

Transforming Primary History Education: Development and Implementation of HistBot, an AI-Powered, Curriculum-Aligned Chatbot

Tahera Kausar Mohd Khurdus Ansari[1], Akash Anil Choudhary[2]
[1, 2]Thakur Institute of Management Studies, Career Development & Research (TIMSCDR), Dept of MCA, Mumbai University, Mumbai, Maharashtra-India
Corresponding Author *: [1]taheraansary@gmail.com, [2]akash01082001@gmail.com

Abstract

Traditional methods of primary education often fail to engage students effectively in subjects like history, leading to limited retention and understanding. This paper introduces HistBot, an AI-powered chatbot designed to enhance the history learning experience for 4th standard students in Maharashtra. Aligned with the state's history curriculum, HistBot leverages machine learning and natural language processing to provide interactive, curriculum-based responses that engage students and improve comprehension. The system incorporates tools like CiteGen AI and a history-themed Wordle game, enhancing both learning and accessibility. HistBot is positioned as a transformative educational tool that bridges traditional teaching methods with modern AI-driven solutions, with the potential to improve primary history education outcomes.

Keywords:
AI-Powered Chatbot, Primary Education, History Learning, Curriculum Alignment, Educational Technology, Gamification, Student Engagement

1. Introduction

The education sector faces significant challenges in engaging primary students, particularly in subjects like history that require both memorization and contextual understanding. Traditional methods of teaching history often fail to capture students' interest, especially when the content is vast and not always aligned with the curriculum. This can lead to disengagement and hinder students from fully appreciating the significance of historical events. Additionally, young learners may struggle with retaining and applying historical knowledge due to a lack of interactive,

personalized learning experiences. These limitations highlight the need for innovative tools that not only engage students but also enhance comprehension and retention of historical concepts.

AI-powered educational tools, such as chatbots, present a promising solution to these challenges. By delivering content in a dynamic, conversational format, HistBot seeks to transform the learning process. Aligned with the Maharashtra 4th standard history curriculum, HistBot provides a tailored educational experience, offering students an interactive assistant that can address their queries and guide them through vast historical content. With curriculum-specific responses and gamified elements, HistBot aims to create a more engaging and effective way of teaching history to primary students.

A. Problem Statement

Traditional textbooks are still heavily relied upon for history education in the modern era, but they have significant limitations. While they provide foundational knowledge, they fail to incorporate dynamic, up-to-date content or effectively utilize the internet. When the internet is used, students often encounter inaccurate or unreliable information that is not aligned with the curriculum.Additionally, the vast and deep knowledge presented in textbooks can be too detailed for young learners, leading to confusion and disengagement. These challenges underscore the need for more effective, interactive, and curriculum-aligned educational tools.

1. Traditional textbooks and resources lack integration of accurate, reliable internet tools.
2. Online resources and textbooks are often misaligned with the curriculum.
3. Excessive and irrelevant information complicates student comprehension and retention.

B. Objectives

The primary goal of this research is to design, develop, and evaluate *HistBot*, an AI-powered chatbot that aims to address the challenges faced in teaching history to primary students. By integrating AI with the Maharashtra 4th standard history curriculum, *HistBot* seeks to enhance student engagement, comprehension, and retention of historical concepts.

The key objectives of this study are:

1. Design and develop HistBot, an AI-powered chatbot aligned with Maharashtra's 4th standard history curriculum.
2. Incorporate gamified elements, such as a history-themed Wordle game, to encourage independent exploration.
3. Enhance student engagement through interactive learning experiences.

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

4. Provide curriculum-specific, context-aware responses to improve comprehension.
5. Evaluate *HistBot*'s potential to bridge traditional teaching methods and AI-driven educational solutions for primary history education.

2. Literature Review

A. Existing Educational Tools and Their Limitations

Traditional educational tools, such as textbooks, have long been central to history education but present several limitations. Students often turn to online resources like Google Search, AI tools like ChatGPT, and educational platforms such as BYJU's, which provide supplementary content but may not cater to curriculum-aligned, interactive learning.

1. Focus on Rote Memorization: Textbooks often encourage memorization rather than fostering critical thinking or deeper understanding of historical events.
2. Lack of Interactivity: They fail to provide engaging, interactive experiences, which are crucial for keeping primary students engaged.
3. Outdated Content: Textbooks do not offer real-time updates or adapt to new information, limiting their relevance.
4. Irrelevant or Inaccurate Information: The internet provides vast amounts of information but often overwhelms students with content that is not aligned with the curriculum or contains inaccuracies.
5. Generalized Responses: Tools like Google Search and AI systems like ChatGPT are not specifically tailored to curriculum requirements, leading to generalized or off-topic responses that don't address students' specific learning needs.

B. AI-Driven Chatbot for Enhancing Learning for Students

AI-powered chatbots have emerged as a promising solution to enhance student learning through personalized and interactive methods. Key findings from the research of Manan Shah (2023) highlight the following benefits:

1. Personalized Learning: AI chatbots provide context-aware, customized responses, addressing the individual learning needs of students.
2. Increased Engagement: These chatbots engage students through dynamic conversations, keeping them interested in the material.
3. Real-time Clarification: They offer immediate feedback and assistance, helping students understand complex topics on the spot.

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

4. Self-Directed Learning: AI chatbots encourage students to explore and learn independently, promoting a deeper understanding of the content.

However, the effectiveness of AI-driven chatbots is contingent upon proper integration with the curriculum:

1. Curriculum Alignment: To ensure the chatbot's responses are educationally valuable, the content must be aligned with specific learning goals and objectives.
2. Potential for Misalignment: Without curriculum alignment, AI chatbots risk providing content that is too generalized, reducing their educational impact.

3. Methodology

The study focuses on understanding the need for a curriculum-aligned chatbot, HistBot, in primary history education. A primary methodology was employed by circulating a questionnaire-based survey via Google Forms to gather insights from key stakeholders, including teachers, students, and parents.

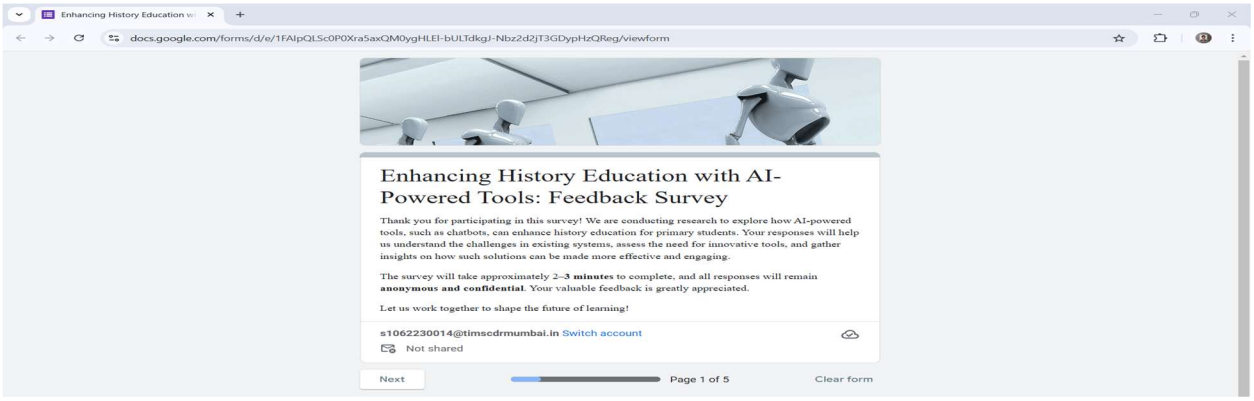


Fig2. Survey via Google Forms

A total of 50 responses were collected, comprising 12 teachers, 30 students, and 8 parents, to gather perspectives from key stakeholders in primary education. The responses were collected anonymously to encourage honest feedback, ensuring a comprehensive understanding of the challenges and needs for an AI-powered educational tool like HistBot.

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

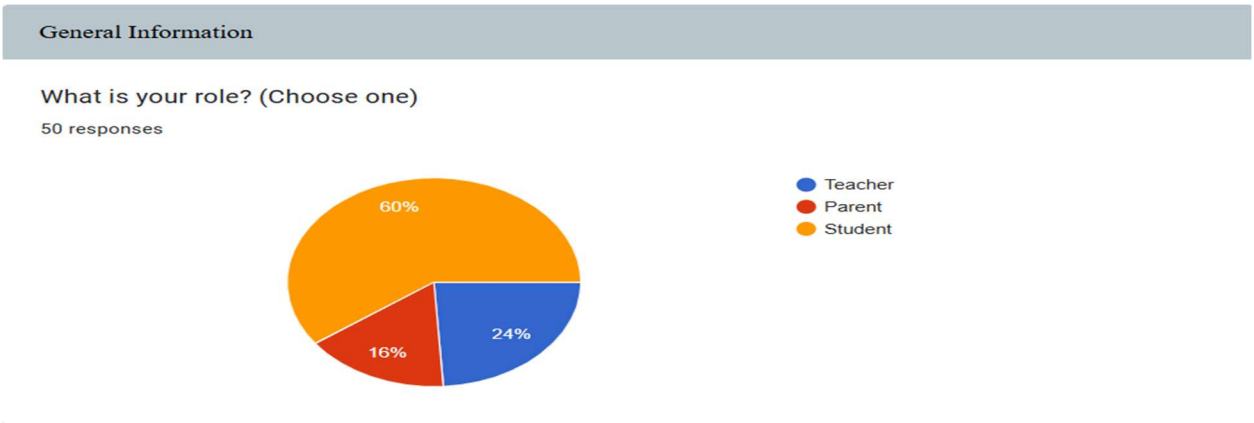


Fig3. Role Distribution of Survey Respondents

The collected responses were carefully analyzed to identify key trends, challenges, and expectations for an AI-powered educational tool, focusing on the needs of both students and educators.

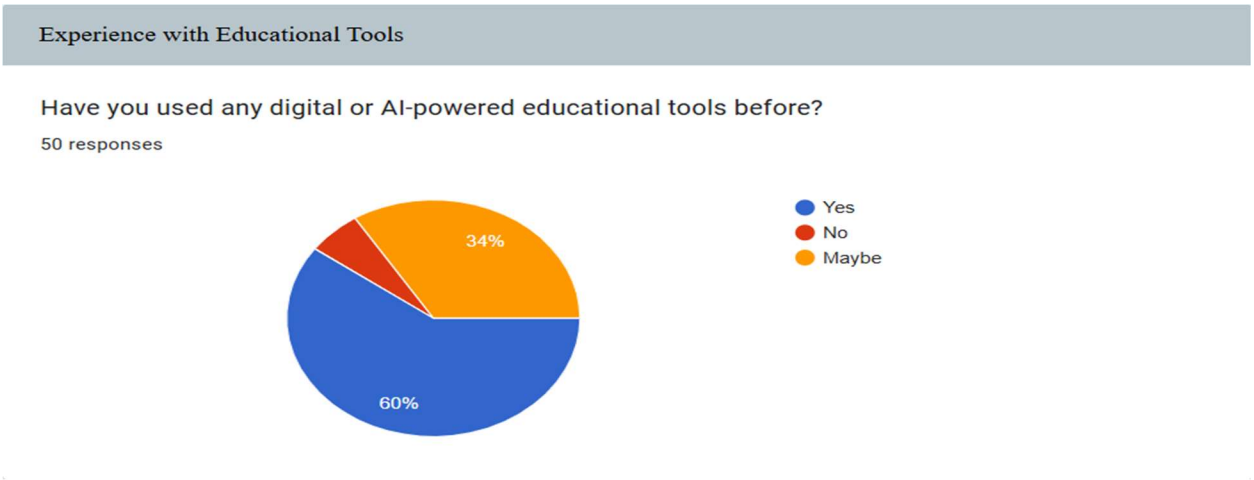


Fig4. Usage of Digital or AI-Powered Educational Tools

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

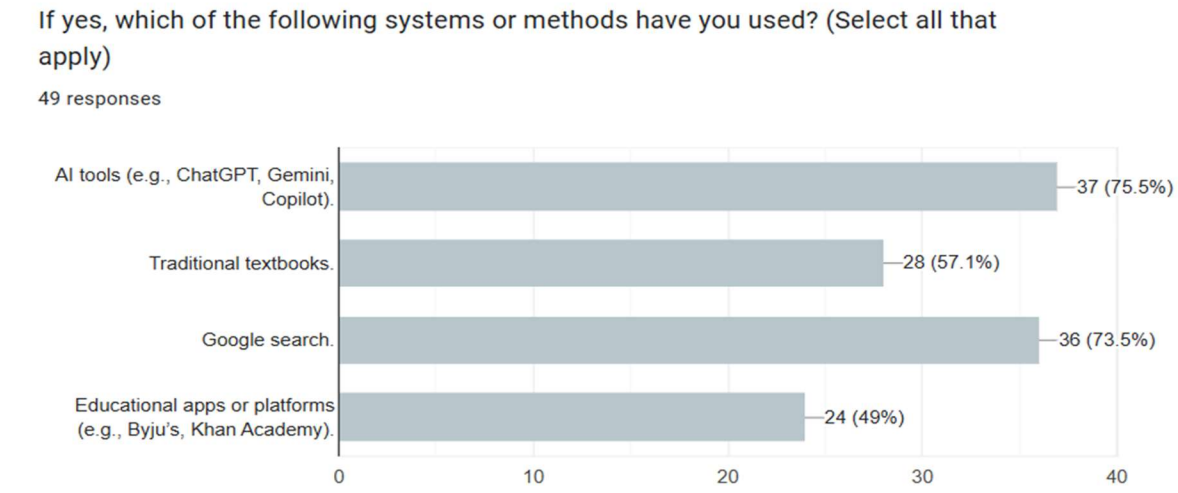


Fig5. Popular Digital or AI-Powered Educational Tools

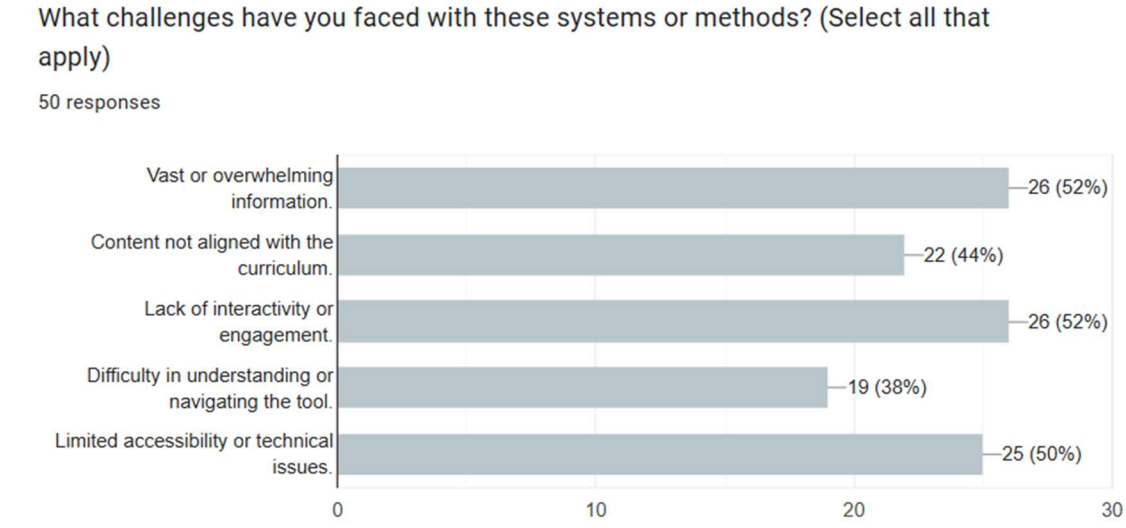


Fig6. Challenges Faced with Digital or AI Tools

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

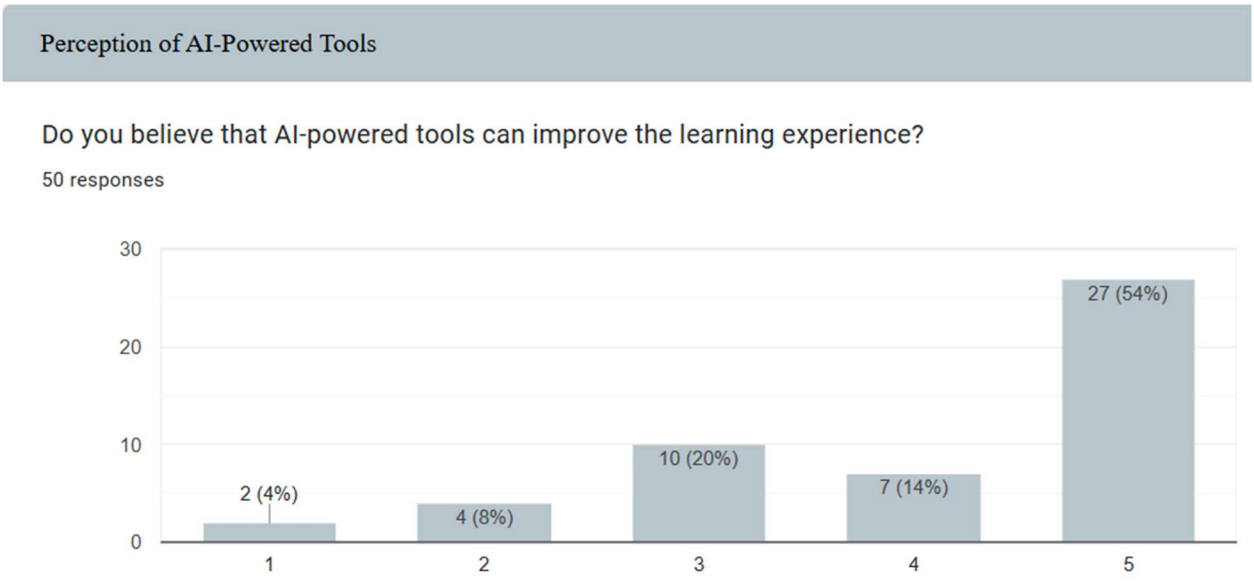


Fig7. Belief in AI Tools Enhancing Learning Experiences

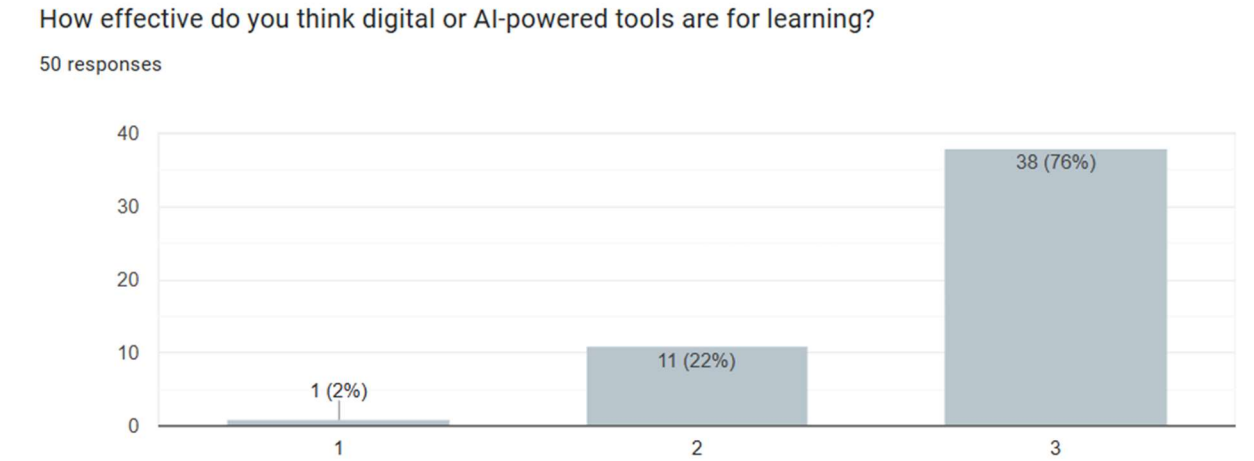


Fig8. Effectiveness of Digital and AI Tools for Learning

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

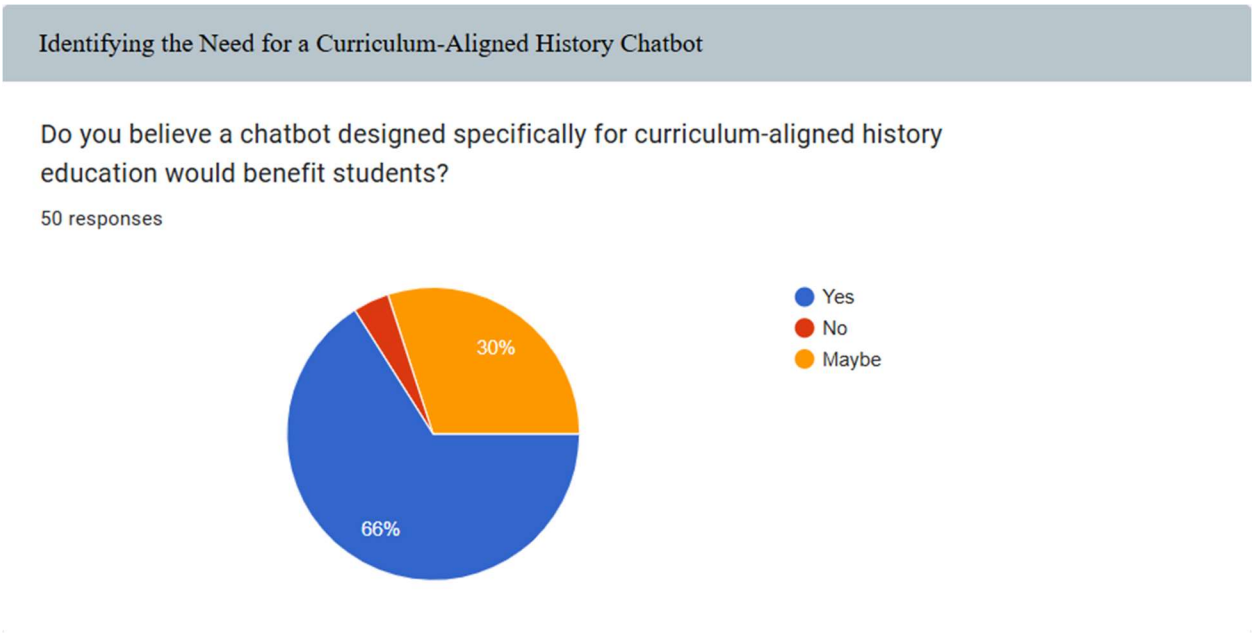


Fig9. Perceived Benefits of a Curriculum-Aligned History Chatbot

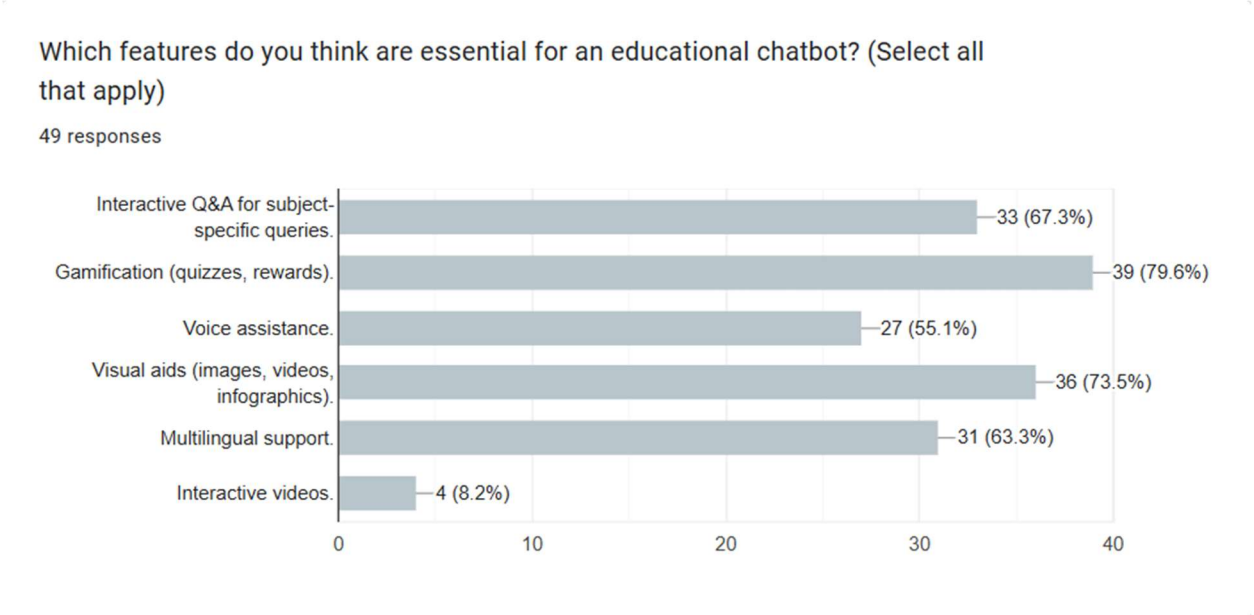


Fig10. Essential Features for an Educational Chatbot

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

Findings from the survey highlighted the demand for an interactive and personalized chatbot tailored to the curriculum. Specific features and functionalities were identified, such as interactive Q&A, gamification, and curriculum alignment, which are crucial to enhancing student engagement and comprehension. These insights were instrumental in designing and developing HistBot, ensuring its alignment with stakeholder needs.

4. Implementation

The implementation of HistBot involves several stages, including dataset creation, model development, model evaluation, and integration with tools. Each phase contributes to creating a robust, AI-powered educational chatbot tailored for Maharashtra's 4th standard history curriculum.

A. Dataset Creation

The dataset for HistBot was curated from the Maharashtra 4th standard history textbook, ensuring alignment with the curriculum. The content was carefully validated by subject matter experts to ensure accuracy and relevance. The dataset was then structured in a format that allows for easy extraction of information relevant to students' queries.

1. Curriculum-aligned content: The dataset consists of historical facts, dates, events, and figures relevant to the Maharashtra state history curriculum.

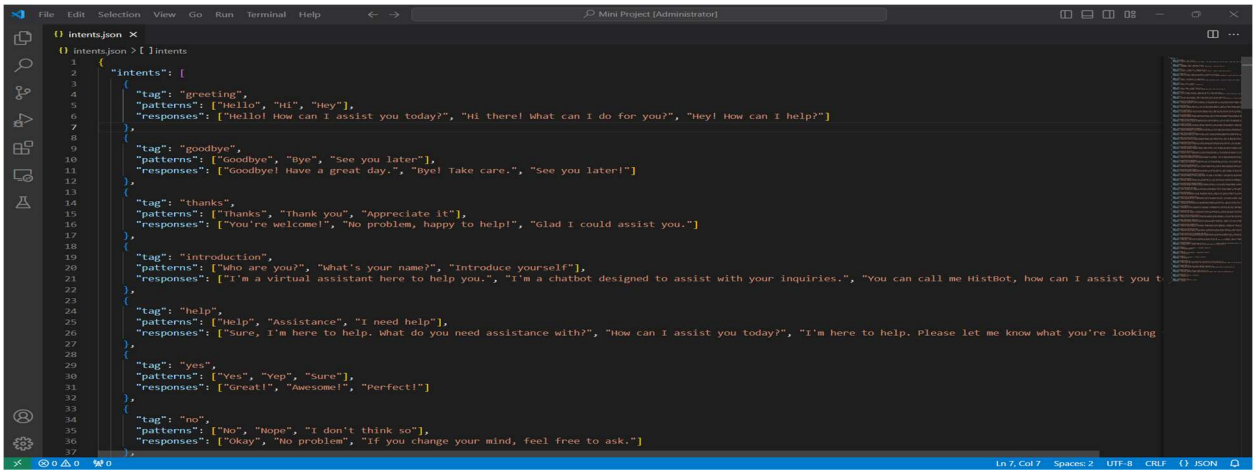


Fig11. intents.json

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

The dataset was then converted into a structured intents.json format, which includes intents related to key historical events, people, and exercises, allowing HistBot to provide contextual responses to student queries.

B. Model Development

The development of HistBot involved using machine learning techniques, specifically natural language processing (NLP), to enable the model to understand and respond to user queries in a conversational manner. A neural network-based classification model was implemented using TensorFlow.

AI Techniques Used:

1. Neural Network (ANN): A neural network model was used for intent classification, allowing HistBot to recognize and map user queries to appropriate responses in the dataset.
2. NLP: Tokenization, lemmatization, and bag-of-words techniques were used to preprocess and analyze user input.

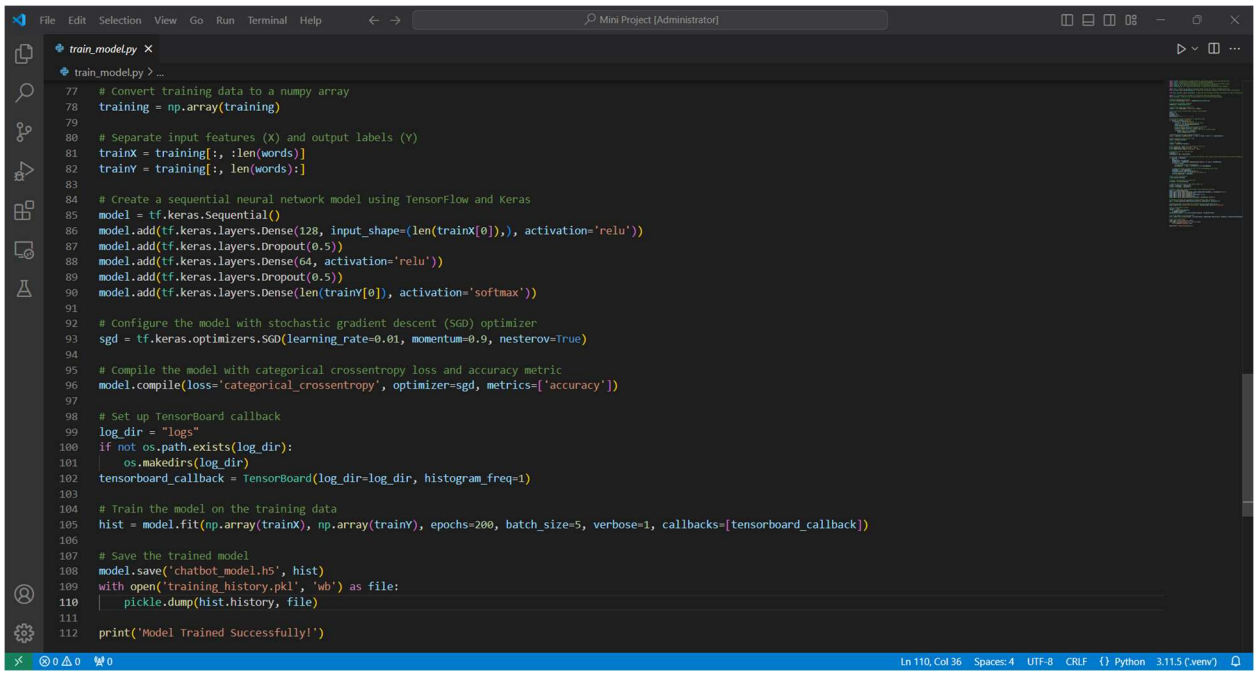


Fig12. train_model.py

Training Process:

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

1. The model was trained using the dataset in the intents.json file, where each query corresponds to a specific intent and response.
2. Parameters: The model was trained using TensorFlow with an Adam optimizer and a learning rate of 0.001. The loss function used was categorical cross-entropy for multi-class classification. Training occurred over 100 epochs with a batch size of 16 and a validation split of 0.2. The hidden layers utilized ReLU activation, whereas the output layer employed softmax activation.
3. Tools and Frameworks: The training process involved using Python and TensorFlow as the core frameworks. NLTK was used for text preprocessing tasks like tokenization and lemmatization, while Keras was utilized for building and training the neural network. Scikit-learn was used for dataset splitting and evaluating performance metrics.

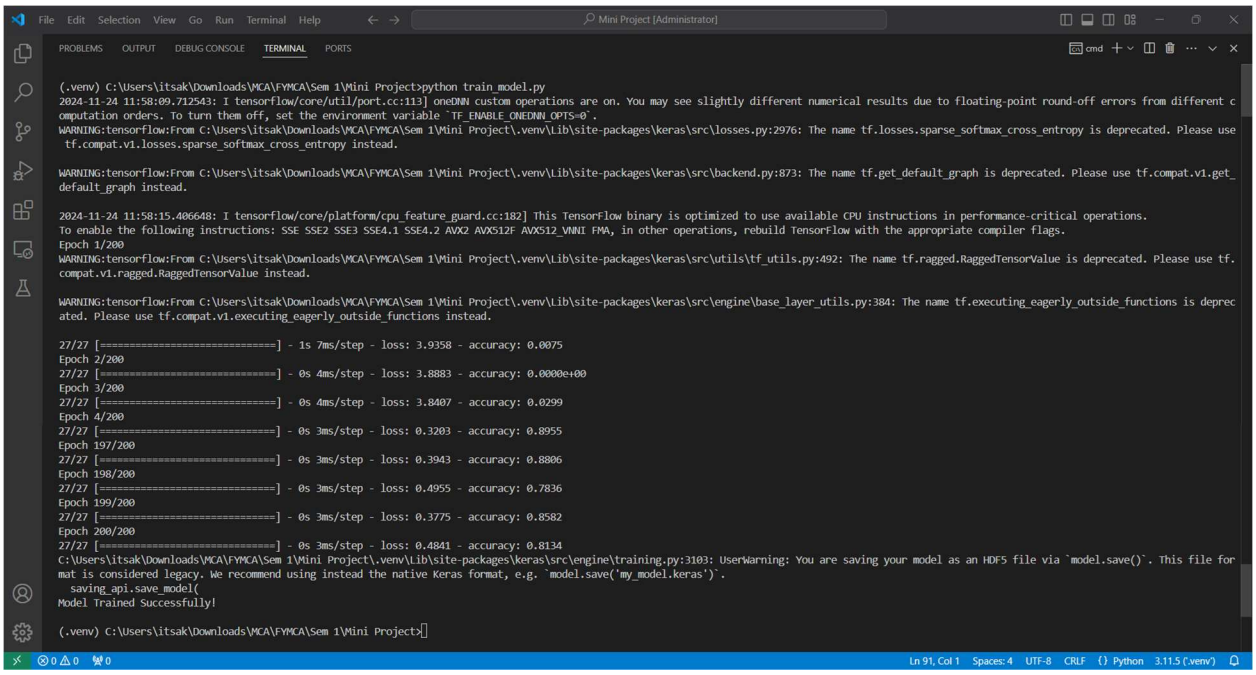


Fig13. Model Training

After training, the model was saved as a .h5 file for integration into the HistBot application.

C. Model Evaluation

The performance of HistBot was evaluated using the accuracy and loss metrics captured during training.

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

1. Accuracy: This metric measures the percentage of correct predictions made by the model out of the total predictions.
2. Loss: This metric reflects the discrepancy between the model's predictions and the true labels, with lower values indicating better performance.

Training Results:
The model's performance improved consistently over the training epochs, as reflected in the decreasing loss and increasing accuracy values. The model effectively understands and responds to student queries based on the curriculum, despite the limited dataset.

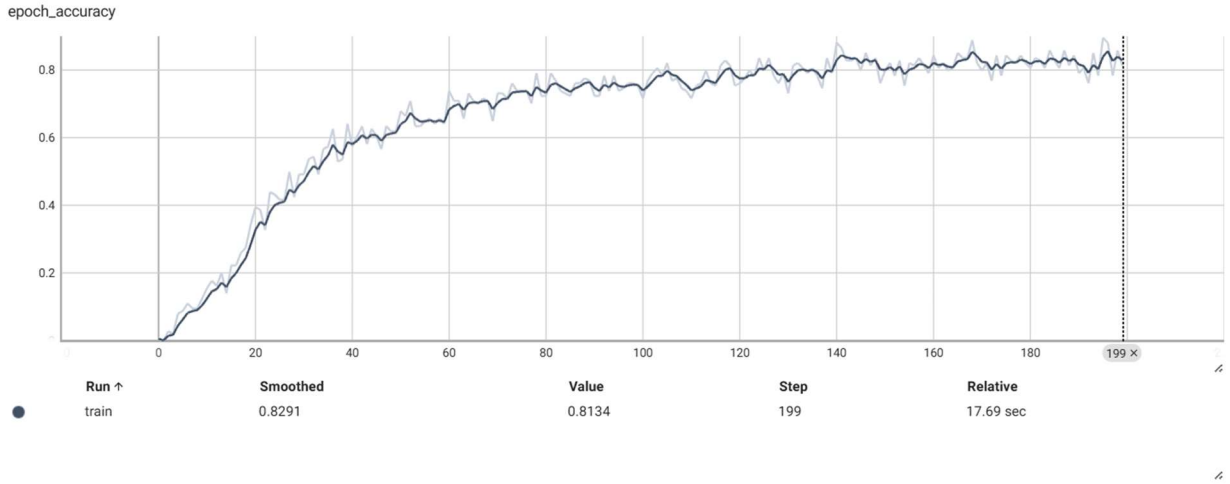


Fig14. epoch_accuracy

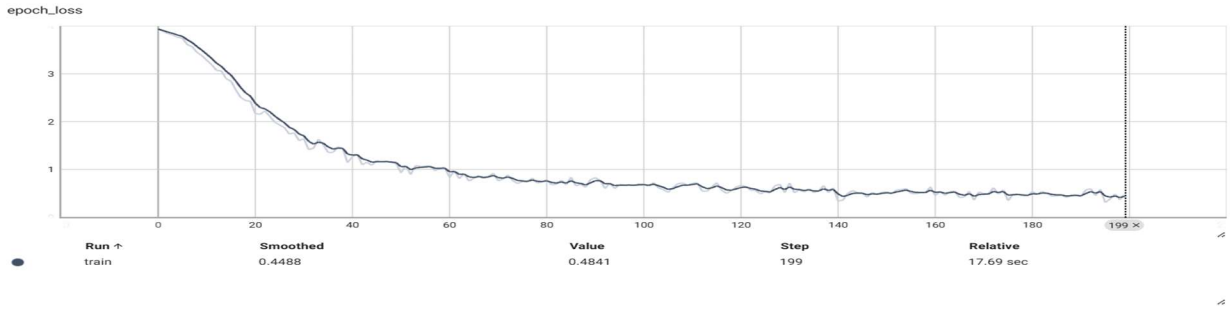


Fig15. epoch_loss

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

With a larger and more diverse dataset, the model's accuracy and performance could be further improved, allowing for better handling of a wider range of student queries. By interpreting the trends in accuracy and loss, HistBot's robust ability to align with the educational curriculum and deliver accurate responses was established.

D. Integration with Tools

HistBot was designed with a user-friendly interface, integrating several key features like CiteGen AI for citations and Wordle for gamification.

The integration process was as follows:

1. User Interface: The user-friendly interface was built using Streamlit, allowing students to easily interact with HistBot in a browser without needing to log in. The intuitive chat interface includes a sidebar where students can seamlessly navigate through different tools. When a student asks a question, the input is processed by the trained model, and an appropriate, contextually relevant response is displayed in the main chat window.

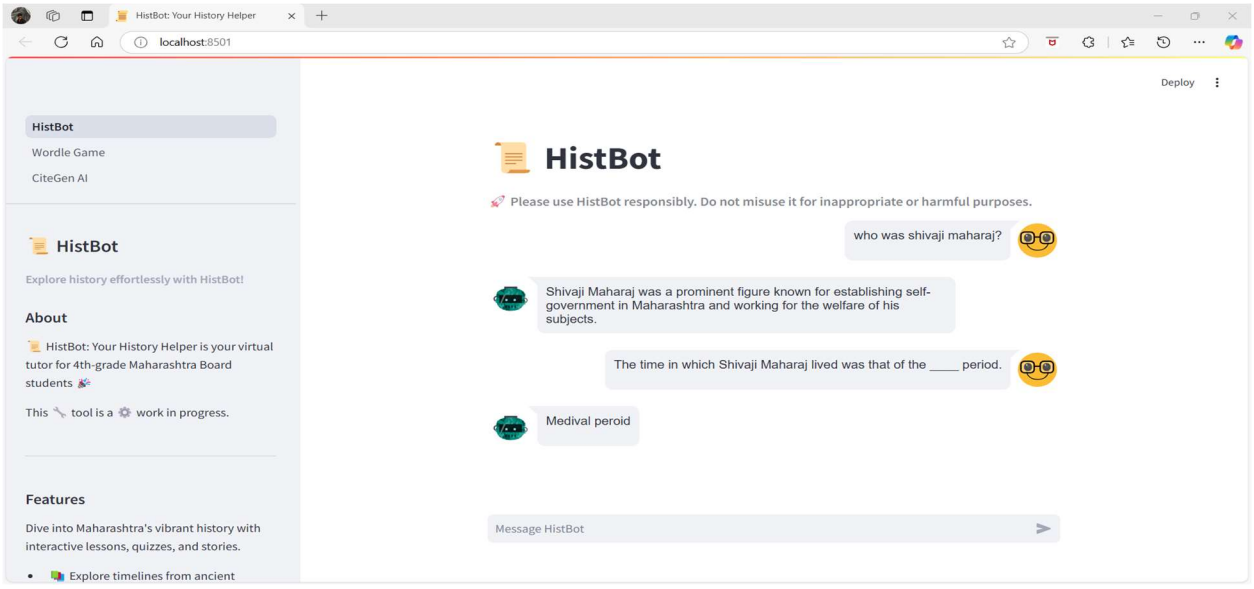


Fig16. HistBot UI

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

2. CiteGen AI for Credible References: CiteGen AI was added as an additional tool to HistBot, enabling students to receive accurate citations alongside responses. It also allows students to upload various files for retrieving relevant information.

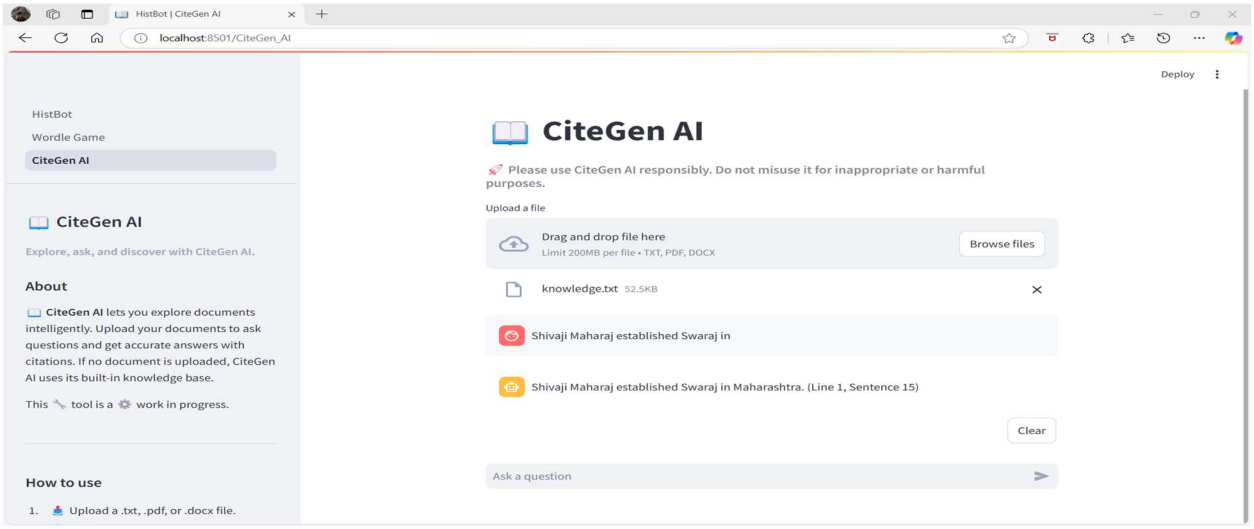
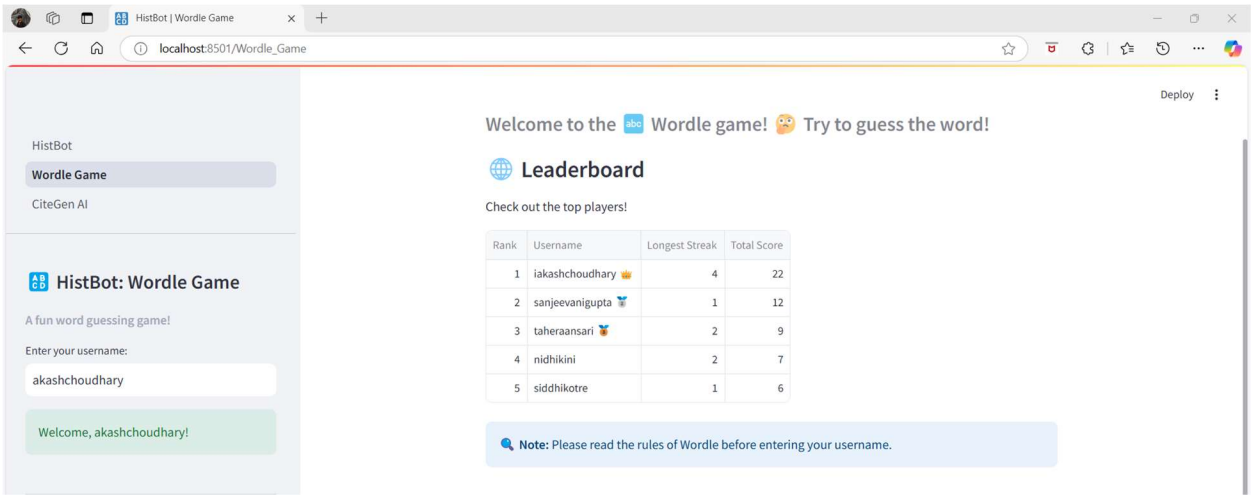


Fig17. CiteGen AI UI

3. Wordle for Gamification: The Wordle Game was added as an additional feature in HistBot to reinforce vocabulary and historical terms. Students can play the game by guessing history-related words, promoting retention of key vocabulary. This gamified feature also fosters student engagement and a competitive spirit among learners.



The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

Fig18. Wordle Game UI – Leaderboard

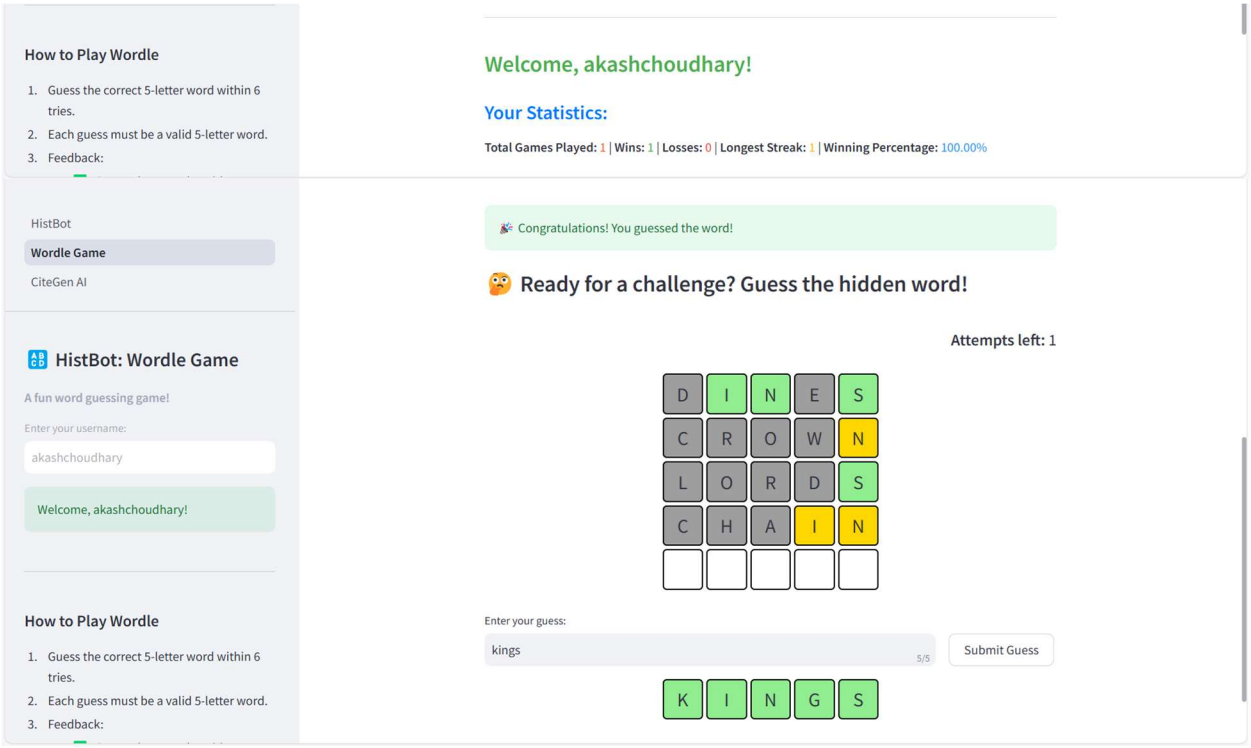


Fig19. Wordle Game UI – Stats & Gameplay Screen

By integrating CiteGen AI and Wordle, HistBot not only serves as an interactive learning assistant but also enhances the overall educational experience by providing reliable references and encouraging vocabulary development.

5. Results Analysis

A. Training and Evaluation Metrics

Table 1. Training vs Evaluation Metrics

Metrics	Training	Evaluation
Accuracy	High (81.34%)	Consistent performance (~81%)

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

Metrics	Training	Evaluation
Loss	Low (0.4841)	Improved after tuning

HistBot's performance was evaluated based on accuracy and loss. During training, the model achieved an accuracy of 81.34% and a loss of 0.4841. After fine-tuning, there was a significant improvement in the loss.

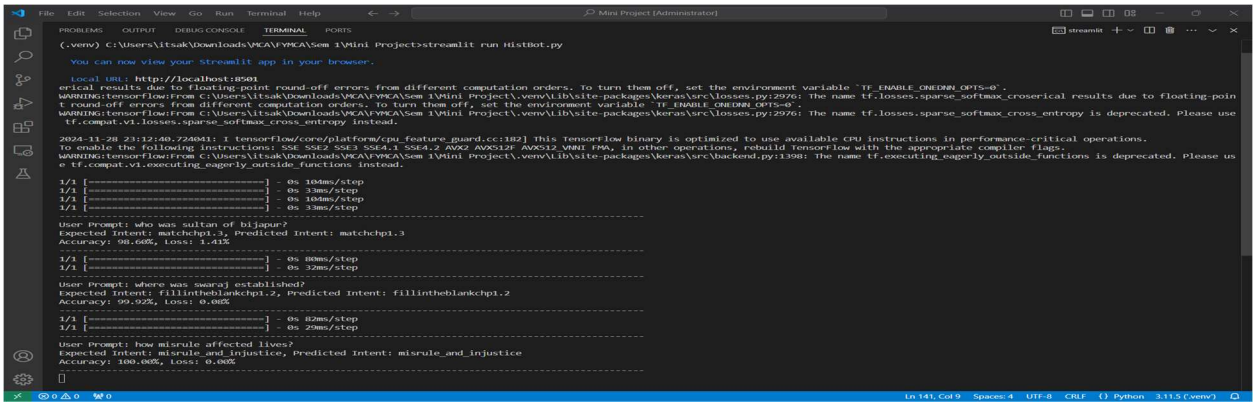


Fig20. Evaluation Metrics

The evaluation accuracy remained stable, indicating that the model generalizes well to unseen data. As the dataset continues to grow, these metrics are expected to improve further.

B. User Engagement

Table 2. User Engagement Outcome

Parameter	Outcome
Student Engagement	High
Interest in Usage	Positive feedback
Gamified Feature Usage	Frequently utilized

The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 3, No 5, May 2025
PP 43– 61

A pilot study involving students showed a high level of engagement, with many students preferring the interactive chatbot over traditional textbooks. The integration of the Wordle game significantly enhanced student participation, promoting regular interaction with the chatbot.

6. Discussion

HistBot enhances primary history education by providing engaging, curriculum-aligned content that ensures accurate, relevant responses to student queries. The AI-driven tool offers immediate feedback, making learning more interactive and accessible. However, challenges remain in handling complex or ambiguous queries, and future improvements could focus on conversational flow, voice interactions, and multilingual support.

Feedback from educators has been positive, with HistBot praised for its ease of use and alignment with curriculum objectives. Teachers highlighted its ability to offer a personalized learning experience. Future developments may expand HistBot's coverage to additional subjects and include advanced features for broader educational support.

7. Conclusion

HistBot demonstrates the potential of AI-driven tools to transform primary education, especially in history learning. By aligning with the curriculum, offering interactive, immediate feedback, and integrating gamification, HistBot fosters student engagement and enhances the learning experience. The model has proven effective in addressing the educational needs of students while providing them with an innovative way to interact with historical content. Future research will focus on scaling HistBot to cover additional subjects and grades, enhancing its interactivity through voice features, and expanding its multilingual support. With continuous improvements, HistBot has the potential to become an essential tool in primary education.

8. Future Work

HistBot will focus on enhancing its capabilities and expanding its reach to offer a more robust and personalized learning experience. The key areas for improvement and development include:

1. Expanding Scope: Extending HistBot's coverage to include other grades and subjects to make it a comprehensive educational tool.
2. Voice-Based Interactions: Integrating voice interaction features to provide greater accessibility, especially for younger students or those with disabilities.

3. Interactive Videos and Animations: Adding interactive videos or animated content to foster deeper engagement and make historical learning more dynamic.
4. Gamification Enhancement: Incorporating additional educational games beyond Wordle to further engage students and support diverse learning styles.
5. Multilingual Support: Expanding HistBot's language capabilities to support multiple languages, ensuring it can be utilized by a broader range of students from various linguistic backgrounds.

These improvements aim to make HistBot an even more powerful tool in transforming primary education by offering greater interactivity, adaptability, and scalability.

Acknowledgment

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