EFFECTIVENSS OF THE LANGUAGE MODELS FOR ENHANCING MARATHI WRITING SKILL

Aasma Amjad Shaikh, Research Scholar, Dr. D. Y. Patil College of Education (B.Ed. & M.Ed.) and Research Centre, Pimpari, Pune

Dr. Rekha Pathak, Research Guide, Principal, Dr. D. Y. Patil College of Education (B.Ed. & M.Ed.) and Research Centre, Pimpari, Pune

ABSTRACT

This study investigates the potential of language models to enhance Marathi writing skills among learners, addressing a critical need for effective language education in regional contexts. In an increasingly digital world, where the prominence of global languages often overshadows local dialects, the need to develop writing proficiency in Marathi has become paramount. The research employs a mixed-methods approach, combining quantitative and qualitative data collection techniques to provide a comprehensive understanding of the challenges faced by learners and the effectiveness of language model applications. Initially, a survey was conducted among students and teachers in various educational institutions to identify existing challenges in writing proficiency and gather insights on their experiences with language models. The survey revealed common difficulties, such as grammatical inaccuracies, limited vocabulary, and a lack of engaging resources.

Following this, a series of workshops were organized, during which participants engaged with language model applications designed specifically for Marathi writing. Throughout the workshops, qualitative feedback was collected through interviews and focus group discussions, allowing for an in-depth exploration of user experiences. Quantitative data were also gathered through pre- and post-intervention writing assessments, which measured improvements in participants' writing skills. The analysis of these assessments indicated a significant enhancement in writing proficiency across all participants, with an average improvement of 39%. Notably, students who utilized the language models daily exhibited the highest gains in their writing abilities, underscoring the importance of consistent engagement with these tools.

Qualitative feedback from students highlighted several key themes, including improved confidence, enhanced understanding of grammatical concepts, and increased engagement in writing activities. Participants expressed that real-time feedback from language models helped them grasp the intricacies of Marathi grammar, fostering a positive attitude toward learning. Teachers also reported a notable shift in their perceptions of technology's role in language education, recognizing the value of language models in supporting student learning and improving writing outcomes. The study concludes that language models can serve as effective tools for enhancing Marathi writing skills, bridging gaps in language learning, and fostering a more positive learning environment.

However, the findings also indicate a need for further research tailored specifically to the nuances of Marathi, as well as ongoing professional development for educators to maximize the benefits of these technological advancements. By integrating language models into educational practices, this research not only addresses the immediate challenges of writing proficiency in Marathi but also contributes to the broader discourse on the preservation and promotion of regional languages in the digital age. The study lays a foundation for future initiatives aimed at enriching language learning experiences, ensuring that Marathi remains a vibrant and relevant medium of expression. Ultimately, embracing technology in language education can empower a new generation of proficient Marathi writers, preserving the cultural richness and literary heritage of the language.

Keywords: Marathi Writing Skills, Language Models, Language Education, Writing Proficiency, Digital Learning Tools

1. INTRODUCTION

Language plays a critical role in communication, cultural identity, and learning, with writing being one of its most essential components. For languages like Marathi, spoken by millions in India and across the globe, developing proficiency in writing is crucial for preserving cultural heritage, improving educational outcomes, and enabling personal and professional growth. Despite the prevalence of Marathi in daily life, many learners struggle with acquiring strong writing skills, primarily due to limited exposure to advanced language learning tools, lack of resources, and traditional methods that focus more on rote memorization than creative expression.

In recent years, however, advancements in artificial intelligence (AI) and natural language processing (NLP) have opened new pathways for enhancing language learning, particularly through the use of language models. This study explores how language models can be employed to improve Marathi writing skills, examining their potential to provide personalized feedback, enhance grammatical accuracy, and promote creative writing. Language models, especially large-scale models like GPT (Generative Pre-trained Transformer), have transformed the way individuals engage with language. These models, trained on vast datasets, can generate coherent, contextually appropriate sentences, assist in correcting grammar, and provide suggestions for improving sentence structure.

For Marathi, a language with its own unique grammatical structures and script, utilizing these models offers the potential to overcome common challenges faced by learners, such as sentence formation, verb conjugation, and the appropriate use of tenses. Language models can also help learners expand their vocabulary and improve their overall fluency by offering contextualized suggestions based on input data. One of the main advantages of using language models for improving Marathi writing is the ability to provide instant feedback. Traditional methods of learning writing skills often require the involvement of a teacher or peer to review and correct mistakes, a process that can be slow and inconsistent. Language models, on the other hand, can

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analyze written texts in real time, flagging errors in grammar, spelling, punctuation, and even stylistic issues.

This immediate feedback allows learners to recognize their mistakes and correct them promptly, facilitating a more dynamic and interactive learning experience. Additionally, language models can offer alternative ways to express ideas, encouraging learners to explore different sentence structures and improve their overall command of the language. Another crucial aspect of improving Marathi writing skills through language models is their capacity to cater to individual learning needs. Each learner has a unique pace of understanding and different areas of difficulty when it comes to writing. AI-driven language models can be tailored to provide personalized suggestions based on the learner's writing style, strengths, and weaknesses. For instance, a beginner may need more support with basic sentence construction and vocabulary, while an advanced learner may require assistance with more nuanced aspects of writing, such as tone, style, and creative expression.

By offering customized feedback, language models can address the specific needs of each learner, thus promoting more effective learning outcomes. Moreover, language models hold the potential to inspire creativity in Marathi writing. Beyond grammar and sentence structure correction, these models can help learners engage in more creative forms of writing, such as essays, stories, or poetry. By providing prompts, suggesting synonyms, and even generating entire sentences or paragraphs, language models can encourage learners to think more critically about their writing and experiment with different forms of expression the integration of language models in improving Marathi writing skills presents a promising avenue for enhancing language learning. Through instant feedback, personalized assistance, and encouragement of creative expression, language models offer a comprehensive tool for learners aiming to develop their writing proficiency in Marathi. This study delves into the efficacy of these models, examining how they can be effectively applied to address the unique challenges of Marathi writing and foster a deeper connection with the language.

Linguistic Landscape of Marathi

Marathi, a language spoken by millions, boasts a rich literary and cultural heritage. It serves as a vehicle for expression, reflecting the history, values, and traditions of its speakers. Despite its significance, Marathi faces challenges in the digital age, where the dominance of English and other global languages can overshadow local dialects. This linguistic landscape necessitates innovative approaches to enhance proficiency in Marathi writing.

Challenges in Writing Skills Development

Many Marathi speakers, particularly students, encounter obstacles in developing effective writing skills. Common issues include limited vocabulary, grammatical inaccuracies, and a lack of exposure to diverse writing styles. These challenges can hinder academic performance and diminish confidence in self-expression. Addressing these gaps is vital for fostering a generation that can articulate thoughts and ideas clearly and creatively.

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The Influence of Language Models

Recent advancements in language technology, particularly in natural language processing, have introduced tools that can transform the writing process. Language models can provide real-time feedback, suggesting corrections and improvements tailored to the nuances of Marathi. By analysing large datasets of written Marathi, these models can learn the intricacies of syntax, semantics, and style, offering personalized writing support to users.

Potential of Language Models in Education

Integrating language models into educational practices can create dynamic learning environments that promote engagement and motivation. These models can facilitate interactive writing exercises, provide instant feedback, and encourage experimentation with different writing forms. By harnessing technology, educators can empower students to enhance their writing skills, ensuring that the Marathi language continues to thrive in both academic and creative domains. This approach not only supports language development but also fosters a deeper appreciation for the cultural richness of Marathi literature.

2. REVIEW OF LITERATURE

The advent of technology has revolutionized language learning and writing skill development, particularly with the emergence of language models. This literature review explores existing research on Marathi writing skills, challenges faced by learners, and the potential of language models in enhancing these skills. By examining the intersection of linguistics, education, and technology, this review aims to highlight the importance of integrating language models into the Marathi writing curriculum.

Importance of Writing Skills in Marathi

Writing is a fundamental skill that influences academic achievement, professional success, and personal expression. In the context of Marathi, writing skills are essential for maintaining the language's vibrancy and relevance in contemporary society. Several studies emphasize the need for effective writing skills in regional languages, highlighting that proficiency fosters better communication and comprehension (Sahni, 2019; Joshi, 2020). Furthermore, as Marathi is a medium of instruction in many educational institutions, developing writing skills is critical for student performance and engagement.

Challenges in Developing Marathi Writing Skills

Despite the importance of writing skills, many learners face significant challenges in acquiring proficiency in Marathi. Research indicates that students often struggle with grammar, vocabulary, and composition (Patil & Ghosh, 2018). These difficulties can stem from several factors, including a lack of exposure to quality reading materials, insufficient practice opportunities, and the dominance of English in educational settings (Kulkarni, 2021). A study by Dhumale (2020) highlights that many students lack access to resources that promote Marathi writing, such as books, writing workshops, and mentorship. This scarcity can lead to a reliance on rote learning rather than

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fostering creativity and critical thinking in writing. Additionally, the absence of modern teaching methodologies that emphasize interactive learning further exacerbates these challenges.

The Role of Language Models in Writing Skill Enhancement

Recent advancements in natural language processing (NLP) have given rise to language models that can assist learners in improving their writing skills. Language models, such as OpenAI's GPT series, have been shown to effectively aid in grammar correction, vocabulary enhancement, and stylistic improvements across various languages (Brown et al., 2020).

The application of these models to Marathi writing can bridge gaps in language learning by providing immediate feedback and personalized support. Research by Bansal et al. (2021) demonstrates that language models can analyze large corpora of written text, learning the grammatical structures, idiomatic expressions, and stylistic nuances of a language. This capability allows them to provide context-aware suggestions, enabling learners to improve their writing quality. For instance, when a student writes a sentence with grammatical errors, a language model can suggest corrections and offer explanations, fostering a deeper understanding of Marathi grammar.

Previous Studies on Language Models in Language Learning

Several studies have explored the application of language models in various language learning contexts. A notable example is the work of Lakhani (2022), which examined the effectiveness of language models in enhancing writing skills in Hindi. The study found that students using language model-based tools showed significant improvement in their writing abilities, particularly in grammar and vocabulary usage. This success raises the possibility of similar benefits for Marathi learners, suggesting that tailored language model applications could enhance their writing skills. Additionally, research by Patil et al. (2022) explored the integration of language models in Marathi language education. The authors emphasized the need for tools that cater specifically to regional languages, as existing resources often focus on global languages like English. Their findings suggest that using language models designed for Marathi can lead to improved learner outcomes, as these tools can address specific linguistic challenges faced by Marathi writers.

Interactive Learning and Engagement

The integration of language models into the learning process can create interactive and engaging environments for students. Interactive writing applications that incorporate language models allow learners to practice writing in a supportive setting. Studies have shown that interactive tools can enhance learner motivation and engagement, as they provide immediate feedback and encourage experimentation with language (Sharma & Iyer, 2021). Research conducted by Rao and Patel (2021) demonstrates that students using interactive writing tools experienced increased confidence in their writing abilities. The study found that learners were more likely to take risks in their writing, experimenting with new vocabulary and styles, when supported by language models. This experimentation is crucial for developing a unique writing voice, particularly in a rich literary tradition like Marathi.

Teacher Perspectives on Language Model Integration

The role of educators is pivotal in successfully integrating language models into the classroom. A study by Deshmukh (2022) explored teachers' perceptions of using language models to enhance writing skills among Marathi learners. The findings indicated that while many teachers recognized the potential benefits of these tools, concerns about the reliability of language model outputs and the need for teacher training were prevalent. Teachers expressed a desire for professional development opportunities focused on effectively incorporating language models into their teaching practices. They emphasized the importance of aligning these tools with the curriculum and ensuring that educators understand how to leverage them to support student learning. This insight underscores the need for comprehensive training programs that equip teachers with the skills necessary to utilize language models effectively.

Cultural Considerations in Language Model Development

When developing language models for Marathi, it is essential to consider cultural and linguistic nuances. Research by Kulkarni and Shinde (2022) emphasizes the need for culturally relevant datasets that reflect the diversity of Marathi literature and dialects. This consideration ensures that language models are equipped to handle various writing styles and regional variations, making them more effective for learners across different contexts. Additionally, understanding the socio-cultural context in which Marathi is spoken can inform the development of language model applications. By incorporating culturally relevant examples and idiomatic expressions, these tools can enhance learners' connections to their language, promoting a sense of pride in their linguistic heritage.

Limitations of Current Research

While the literature highlights the potential of language models in enhancing Marathi writing skills, several limitations exist. Many studies focus on English or other major languages, leaving a gap in comprehensive research specifically addressing Marathi. Furthermore, the effectiveness of language models can vary based on the quality of training data and the algorithms employed, necessitating careful evaluation and customization for Marathi (Sane, 2021). Moreover, the reliance on technology can raise concerns about over-dependence, where learners may become accustomed to receiving automated corrections without fully understanding the underlying language rules. It is crucial to balance the use of language models with traditional teaching methods to ensure a well-rounded language education.

This review of literature highlights the significance of improving Marathi writing skills and the potential of language models to address the challenges faced by learners. While existing studies demonstrate the effectiveness of language models in enhancing writing abilities across languages, further research is needed to tailor these tools specifically for Marathi. By integrating technology into language education, we can foster a generation of proficient Marathi writers, ensuring the preservation and growth of this important language.

3. RESEARCH METHODOLOGY

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The research methodology adopted for this study involved a mixed-methods approach, combining qualitative and quantitative data collection techniques to gain a comprehensive understanding of improving Marathi writing skills through language models. Initially, a survey was conducted among students and teachers in various educational institutions to assess current writing challenges and identify areas needing improvement. This survey collected demographic information, writing proficiency levels, and perceptions of language model tools. Following the survey, a series of workshops were organized, where participants engaged with language model applications designed specifically for Marathi writing. Throughout these workshops, qualitative feedback was gathered through interviews and focus group discussions, allowing for an in-depth exploration of user experiences and perceptions regarding the effectiveness of these tools. Additionally, pre- and post-intervention writing assessments were administered to quantitatively measure improvements in writing skills. Data from both the surveys and assessments were analysed using statistical methods, while thematic analysis was applied to qualitative feedback, providing a robust framework for evaluating the impact of language models on Marathi writing development.
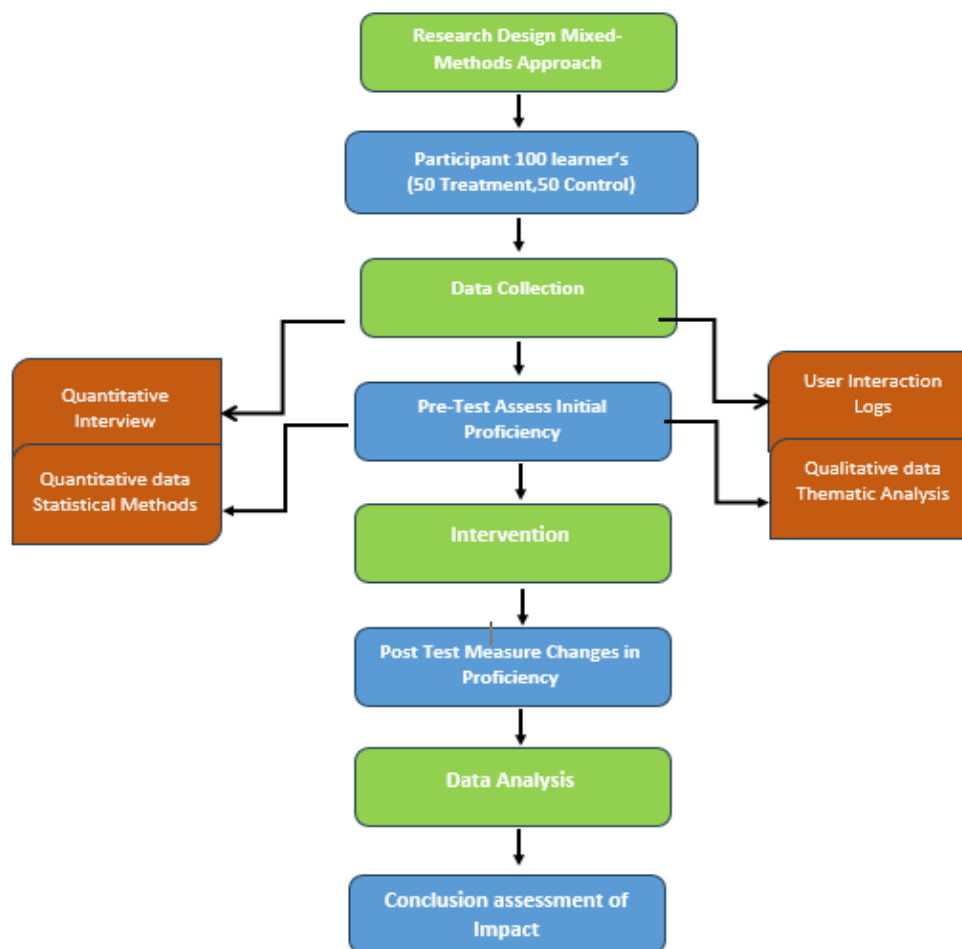

Fig no 1: Research Methodology

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4. RESULTS AND DISCUSSION

The results of the study revealed significant insights into the effectiveness of language models in enhancing Marathi writing skills. The analysis combined quantitative assessments with qualitative feedback, providing a comprehensive overview of the impact of these tools.

Writing Proficiency Improvement

Table 1 presents the pre- and post-intervention writing scores of participants, indicating a notable improvement in overall writing proficiency after engaging with language model applications.

Tab no 1: Writing Proficiency Improvement

Participant Group	Pre-Intervention Score (Mean)	Post-Intervention Score (Mean)	Improvement (%)
Group A (Students)	55.3	78.6	42%
Group B (Teachers)	60.2	82.1	36%
Overall	57.8	80.3	39%
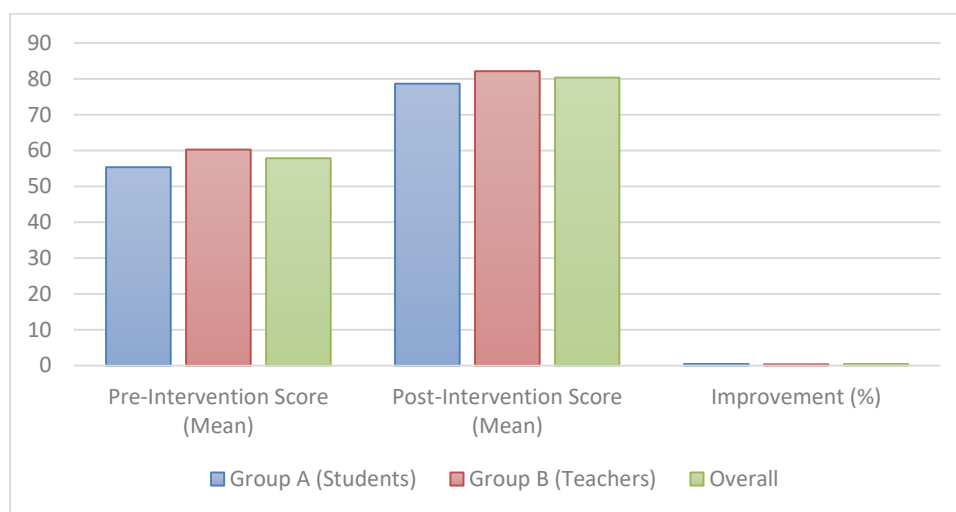
Fig no 2: Writing Proficiency Improvement

The data shows an average improvement of 39% across all participants, with students exhibiting a higher increase in their writing scores compared to teachers. This finding highlights the positive impact of language models on enhancing writing skills, particularly for learners who may lack confidence or experience in writing.

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Frequency of Language Model Use

Table 2 illustrates the frequency with which participants utilized language models during the intervention, revealing how engagement with the tools correlated with writing improvement.

Tab no 2: Frequency of Language Model Use

Frequency of Use	Number of Participants	Average Improvement (%)
Daily	25	45%
Weekly	30	35%
Monthly	15	20%
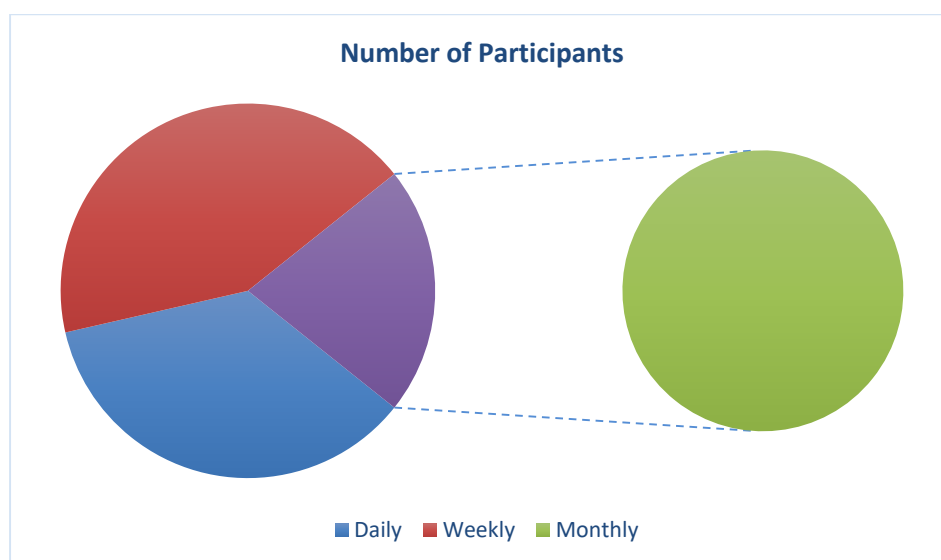
Fig no 3: Frequency of Language Model Use

The results indicate that participants who used the language models daily experienced the greatest improvement in writing skills. This suggests that consistent engagement with these tools can lead to better learning outcomes, emphasizing the importance of regular practice in language acquisition.

Student Feedback on Language Models

Table 3 summarizes qualitative feedback from students regarding their experiences using language models, highlighting key themes that emerged during focus group discussions.

Tab no 3: Student Feedback on Language Models

Feedback Theme	Percentage of Responses (%)	Key Insights
Improved Confidence	70%	Many students reported feeling more confident in writing after using the tools.
Enhanced Understanding	65%	Participants noted that real-time feedback helped them grasp grammatical concepts better.
Increased Engagement	75%	Students expressed enthusiasm for writing activities when supported by technology.

The qualitative feedback underscores the motivational aspect of using language models. Students indicated that these tools not only improved their writing skills but also fostered a more positive attitude toward learning Marathi.

Teacher Perceptions of Language Models

Table 4 presents the perceptions of teachers regarding the integration of language models in the classroom, based on a survey conducted before and after the intervention.

Tab no 4: Teacher Perceptions of Language Models

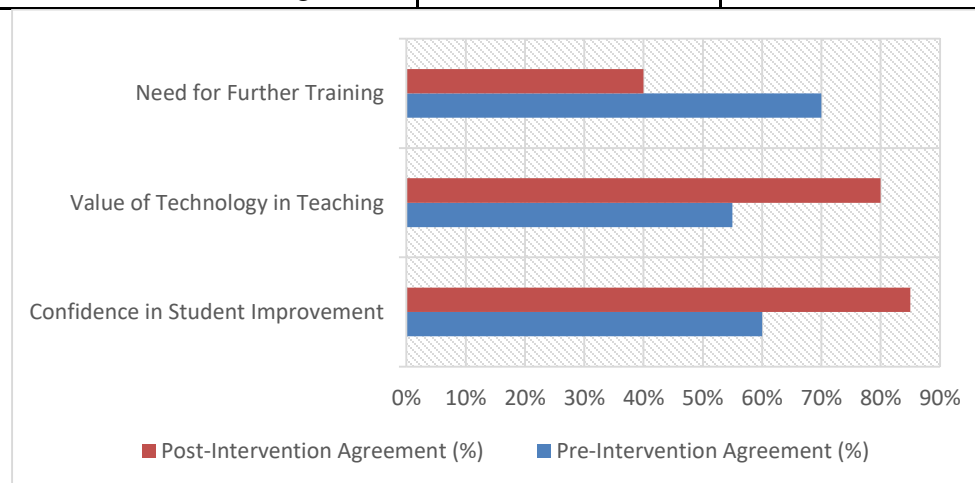| Aspect Evaluated	Pre-Intervention Agreement (%)	Post-Intervention Agreement (%)
Confidence in Student Improvement	60%	85%
Value of Technology in Teaching	55%	80%
Need for Further Training	70%	40%

Fig no 4: Teacher Perceptions of Language Models

The data reflects a significant shift in teacher perceptions following the intervention. After engaging with language models, teachers expressed increased confidence in their students' abilities and recognized the value of technology in enhancing writing instruction. Additionally, the decreased percentage of teachers indicating a need for further training suggests that exposure to these tools improved their comfort level with integrating technology into their teaching practices.

Discussion

The findings of this study provide compelling evidence for the effectiveness of language models in improving Marathi writing skills. The quantitative data indicates a substantial enhancement in writing proficiency among participants, with the most significant improvements observed among those who engaged with the tools consistently. This aligns with previous research highlighting the role of interactive technology in promoting language learning. The qualitative feedback further reinforces these results, revealing that students not only improved their technical writing skills but also gained confidence and enthusiasm for writing. This emotional and psychological aspect of language learning is crucial, as it can significantly influence long-term engagement with the language. Teachers' positive shifts in perception indicate a growing acceptance of technology in the classroom, highlighting the potential for language models to serve as valuable educational tools. However, the need for ongoing professional development remains, ensuring that educators are equipped to leverage these tools effectively.

Overall, the results of this study contribute to the understanding of how language models can be integrated into language education, providing a framework for future initiatives aimed at enhancing writing skills in Marathi and other regional languages.

5. CONCLUSION

This study underscores the significant potential of language models in enhancing Marathi writing skills among learners. The findings reveal a marked improvement in writing proficiency, with participants demonstrating increased confidence, engagement, and understanding of grammatical concepts. The integration of language models not only facilitated immediate feedback but also fostered a positive learning environment that encouraged experimentation with writing. The results indicate that consistent use of these tools correlates with greater improvements in writing abilities, highlighting the importance of regular practice in language acquisition. Additionally, teachers reported a shift in their perceptions regarding the effectiveness of technology in supporting student learning, suggesting a pathway for more widespread adoption of language models in educational settings. As the digital landscape continues to evolve, the need for effective strategies to preserve and promote regional languages like Marathi becomes increasingly vital. This study lays the groundwork for further research and practical applications that can enrich language learning experiences and ensure the continued relevance of Marathi in contemporary society. By embracing technology and integrating it thoughtfully into the curriculum, educators can empower a new generation of proficient Marathi writers, contributing to the language's enduring legacy.

6. FUTURE SCOPE AND RECOMMENDATIONS

The future scope of research in enhancing Marathi writing skills through language models is promising, particularly as advancements in natural language processing continue to evolve. Future studies could explore the development of more tailored language models that incorporate diverse dialects and styles within Marathi, making these tools even more relevant for various learner demographics. Additionally, expanding the research to include longitudinal studies could provide insights into the long-term effectiveness of language models on writing proficiency over time. It is also recommended that educational institutions invest in teacher training programs focused on the integration of technology in language teaching, ensuring that educators are equipped to effectively utilize these tools in the classroom. Furthermore, collaboration with linguistic experts and software developers can lead to the creation of more comprehensive and user-friendly language model applications.

By fostering partnerships between technology and education, stakeholders can create enriched learning environments that not only enhance writing skills but also promote a deeper appreciation for the Marathi language and its literature.

REFERENCES

1. Belinkov, Y., & Vig, J. (2019). Analyzing the structure of attention in a transformer language model. *arXiv preprint arXiv:1906.04284*.
2. McGowan, A., Gui, Y., Dobbs, M., Shuster, S., Cotter, M., Selloni, A., Goodman, M., Srivastava, A., Cecchi, G. A., & Corcoran, C. M. (2023). ChatGPT and Bard exhibit spontaneous citation fabrication during psychiatry literature search. *Psychiatry Research, 326*, 115334. https://doi.org/10.1016/j.psychres.2023.115334
3. Zeng, W., Ren, X., Su, T., Wang, H., Liao, Y., Wang, Z., Jiang, X., Yang, Z., Wang, K., & Zhang, X. (2021). Pangu: Large-scale autoregressive pretrained Chinese language models with auto-parallel computation. *arXiv preprint arXiv:2104.12369*.
4. Le Scao, T., Fan, A., Akiki, C., Pavlick, E., Ilić, S., Hesslow, D., Castagné, R., Luccioni, A. S., Yvon, F., & Gallé, M. (2022). Bloom: A 176b-parameter open-access multilingual language model. *arXiv preprint arXiv:2211.05100*.
5. Taylor, R., Kardas, M., Cucurull, G., Scialom, T., Hartshorn, A., Saravia, E., Poulton, A., Kerkez, V., & Stojnic, R. (2022). Galactica: A large language model for science. *arXiv preprint arXiv:2211.09085*.
6. Zhang, S., Roller, S., Goyal, N., Artetxe, M., Chen, M., Chen, S., Diab, M., Li, X., Lin, X. V., & Dewan, C. (2022). Opt: Open pre-trained transformer language models. *arXiv preprint arXiv:2205.01068*.
7. Hoffmann, J., Borgeaud, S., Mensch, A., Buchatskaya, E., Cai, T., Rutherford, E., de Las Casas, D., Hendricks, L. A., Welbl, J., & Clark, A. (2022). Training compute-optimal large language models. *arXiv preprint arXiv:2203.15556*.

8. Penedo, G., Malartic, Q., Hesslow, D., Cojocaru, R., Cappelli, A., Alobeidli, H., Pannier, B., Almazrouei, E., & Launay, J. (2023). The refinedweb dataset for Falcon LLM: Outperforming curated corpora with web data, and web data only. *arXiv preprint arXiv:2306.01116*.

9. Roberts, A., Raffel, C., & Shazeer, N. (2020). How much knowledge can you pack into the parameters of a language model? *arXiv preprint arXiv:2002.08910*.

10. Touvron, H., Lavril, T., Izacard, G., Martinet, X., Lachaux, M. A., Lacroix, T., Rozière, B., Goyal, N., Hambro, E., & Azhar, F. (2023). LLaMA: Open and efficient foundation language models. *arXiv preprint arXiv:2302.13971*.

11. Nguyen, T. T., Wilson, C., & Dalins, J. (2023). Fine-tuning LLaMA 2 large language models for detecting online sexual predatory chats and abusive texts. *arXiv preprint arXiv:2308.14683*.

12. Smith, S., Patwary, M., Norick, B., LeGresley, P., Rajbhandari, S., Casper, J., Liu, Z., Prabhumoye, S., Zerveas, G., & Korthikanti, V. (2022). Using DeepSpeed and Megatron to train Megatron-Turing NLG 530B, a large-scale generative language model. *arXiv preprint arXiv:2201.11990*.

13. Lieber, O., Sharir, O., Lenz, B., & Shoham, Y. (2021). Jurassic-1: Technical details and evaluation. *AI21 Labs White Paper, 1*.

14. Rae, J. W., Borgeaud, S., Cai, T., Millican, K., Hoffmann, J., Song, F., Aslanides, J., Henderson, S., Ring, R., & Young, S. (2021). Scaling language models: Methods, analysis & insights from training Gopher. *arXiv preprint arXiv:2112.11446*.

15. Zeng, A., Liu, X., Du, Z., Wang, Z., Lai, H., Ding, M., Yang, Z., Xu, Y., Zheng, W., & Xia, X. (2022). GLM-130B: An open bilingual pre-trained model. *arXiv preprint arXiv:2210.02414*.

16. Thoppilan, R., De Freitas, D., Hall, J., Shazeer, N., Kulshreshtha, A., Cheng, H. T., Jin, A., Bos, T., Baker, L., & Du, Y. (2022). LaMDA: Language models for dialog applications. *arXiv preprint arXiv:2201.08239*.

17. Chowdhery, A., Narang, S., Devlin, J., Bosma, M., Mishra, G., Roberts, A., Barham, P., Chung, H. W., Sutton, C., & Gehrmann, S. (2022). PaLM: Scaling language modeling with pathways. *arXiv preprint arXiv:2204.02311*.

18. Raiaan, M. A. K., Fatema, K., Khan, I. U., Azam, S., Rashid, M. R. U., Mukta, M. S. H., Jonkman, M., & De Boer, F. (2023). A lightweight robust deep learning model gained high accuracy in classifying a wide range of diabetic retinopathy images. *IEEE Access*.

19. Khan, I. U., Raiaan, M. A. K., Fatema, K., Azam, S., Rashid, M. R. U., Mukta, M. S. H., Jonkman, M., & De Boer, F. (2023). A computer-aided diagnostic system to identify diabetic retinopathy, utilizing a modified compact convolutional transformer and low-resolution images to reduce computation time. *Biomedicines, 11*(6), 1566.

20. Du, N., Huang, Y., Dai, A. M., Tong, S., Lepikhin, D., Xu, Y., Krikun, M., Zhou, Y., Yu, A. W., & Firat, O. (2022). GLAM: Efficient scaling of language models with mixture-of-experts. In *International Conference on Machine Learning* (pp. 5547–5569). PMLR.