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Multilingual instruction and Natural Language Processing in Indian higher education: A collaborative approach

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ABSTRACT

This study investigates how multilingual instruction (MLI) supported by Natural Language Processing (NLP) tools is perceived and used in Indian higher-education classroom. Particularly as the National Education Policy (NEP) 2020 in India emphasized the need of multilingual instruction in the classroom. However, the implementation of NLP in multilingual classrooms presents challenges, including language diversity, technological accessibility, and the need for culturally sensitive tools. Despite these limitations, the collaborative approach of combining multilingual instruction with NLP can revolutionize higher education by providing equal learning opportunities for all students, regardless of their linguistic backgrounds. 50 faculty members in Jaipur, India, were surveyed through questionnaire and class observations, which include six domains: (1) frequency of incorporating MLI in teaching, (2) challenge in MLI, (3) adoption of NLP tools in MLI, (4) effectiveness of NLP tools, (5) benefit observations from using NLP tools in MLI, and (6) challenge in using NLP tools in MLI. Figures display adoption rates, perceived benefits, and reported challenges. Findings indicate frequent use of MLI, growing but uneven NPL adoption, and perceived benefits in accessibility and participation; key barriers include translation accuracy, training, and infrastructure. Observations show how NLP features (live transcription/translation) facilitate participation, while accuracy issues sometimes disrupt flow. This study concludes with practical implications: targeted faculty development, infrastructure upgrades, and culturally sensitive NLP models. Future study should extend sampling beyond Jaipur and include student outcomes.

Keywords: Multilingual Instruction (MLI), Natural Language Processing (NLP), Indian Higher Education, Inclusive Learning, Language Accessibility

INTRODUCTION

In recent years, higher education institutions have seen an increasing presence of multilingual students. These learners, who come from diverse linguistic backgrounds, often face significant barriers in understanding and engaging with classroom instruction primarily offered in a dominant language. Although the National Education Policy (NEP) 2020 has emphasized the need of multilingual instruction which urges teachers to use multi languages in teaching, the challenges remain (Mahapatra, 2021; Panda & Mohanty, 2014). To address these challenges and to follow NEP 2020, many

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institutions have begun to adopt multilingual instruction (MLI) as a key pedagogical strategy to create more inclusive and equitable learning environments.

Multilingual instruction involves the use of multiple languages in the teaching process to enhance comprehension, participation, and academic success among students who speak different languages (Cummins, 2000). By recognizing and valuing students' native languages, MLI not only supports language learners but also creates an environment of cultural inclusivity. However, despite the advantages of multilingual instruction, many institutions still face substantial challenges in ensuring effective communication across languages. One of the main difficulties is the ability to provide real-time support and translation for diverse linguistic needs. This is where Natural Language Processing (NLP) comes into play.

NLP, a field of artificial intelligence (AI), involves the development of algorithms and models that allow machines to understand, interpret, and generate human language (Manning, 2020). By integrating NLP tools into multilingual classrooms, educators can offer personalized learning experiences, real-time language translation, and automatic feedback, ultimately supporting better comprehension and engagement. The synergy between multilingual instruction and NLP holds significant potential for transforming the learning experience in higher education. NLP-powered tools such as automated translations, voice recognition systems, and context-aware learning applications can help bridge communication gaps between students and instructors (Lopez, 2021). These technologies allow non-native speakers to understand multilingual instruction, communicate more effectively, and overcome language barriers in both synchronous and asynchronous learning environments. For instance, machine translation and speech recognition can provide real-time translation of lectures, enabling multilingual learners to understand academic content in their native language (Joubert & Pedersen, 2019).

However, challenges after challenges always emerge while finding the best method to provide linguistic equality in classroom. Despite its promise, the integration of NLP into multilingual instruction faces problems. The effectiveness of NLP tools depends on factors such as the diversity of languages in the classroom, the quality of NLP models, and the readiness of both students and faculty to adopt these technologies (Mohan et al., 2020). Furthermore, there is a need for culturally sensitive NLP models that can accurately reflect linguistic nuances and cultural contexts. Educational institutions must consider these challenges while exploring the potential of NLP to enhance multilingual instruction and create more inclusive academic environments.

This study examines the role of NLP in facilitating multilingual instruction in Indian higher-education contexts, aligning with the National Education Policy (NEP) 2020 emphasis on multilingualism. It explores how these technologies can address the barriers that multilingual students and faculties face, enhances teaching

methodologies, and promotes equitable learning. By examining the collaboration between multilingual instruction and NLP, this research highlights the transformative potential of these technologies to improve teaching practices and student outcomes in linguistically diverse classrooms.

LITERATURE REVIEW

The growing presence of multilingual students in higher education institutions has necessitated a re-evaluation of pedagogical strategies to accommodate diverse linguistic backgrounds. With the advent of the National Education Policy (NEP) 2020 in India, there has been an increased emphasis on multilingual instruction (MLI) in educational settings. This section explores the current literature on multilingual instruction, the role of Natural Language Processing (NLP), and the challenges faced by educators in fostering multilingual environments in higher education. Saini (2024) investigates the perceptions of students toward multilingual instruction under the framework of the Indian NEP 2020. His study highlights that students recognize the value of MLI in enhancing understanding and participation in academic content. However, challenges such as language proficiency, the availability of resources in multiple languages, and the lack of proper training for teachers in managing multilingual classrooms were identified as significant barriers. Furthermore, it is also stated that while multilingual instruction promotes inclusivity and accessibility, its effectiveness hinges on the implementation of appropriate pedagogical strategies, the training of educators, and the availability of linguistic resources. This aligns with the broader discourse on the need for systemic changes to fully realize the potential of MLI in higher education.

In parallel with the result of previous study, the demand for effective language support in multilingual classroom has increased which led to the incorporation of technology-assisted language learning (TALL). This is where Natural Language Processing (NLP) emerges as a powerful tool. NLP, an interdisciplinary field of artificial intelligence (AI), enables machines to understand and interact with human language in a manner that can facilitate more inclusive and accessible education (Manning, 2020). Through tools such as machine translation, automated speech recognition, and real-time language feedback, NLP has the potential to alleviate some of the challenges associated with multilingual instruction. Studies have shown that NLP-based tools can support both students and educators by providing seamless translation services, reducing the cognitive load associated with language barriers, and promoting engagement in academic activities (Joubert & Pedersen, 2019).

The application of NLP in multilingual classrooms turns out to appear without challenges. While NLP tools are designed to assist with language comprehension, the diversity of languages with its cultural nuances pose significant challenges for accurate

translation and contextual interpretation (Mohan et al., 2020). For instance, the quality of machine translation may vary depending on the language pairs involved, with some languages being underrepresented in training data, leading to suboptimal outcomes (Lopez, 2021). Furthermore, NLP tools must be culturally sensitive to the context in which they are used. Educational systems must ensure that the technology is inclusive not just in terms of linguistic diversity but also in its ability to respect and represent cultural differences. One of the key arguments in the literature surrounding multilingual education is the importance of developing a culturally responsive curriculum. According to Gay (2010), culturally responsive teaching methods are crucial for ensuring that multilingual students feel valued and included in their learning experiences. The integration of culturally appropriate resources, such as literature, history, and examples from diverse cultures, ensures that the content is relatable and accessible. Culturally responsive pedagogy can be enhanced through the use of NLP, which can facilitate the development of content that resonates with students from diverse linguistic backgrounds by offering customized, contextually appropriate language support (Kramsch, 2009). Furthermore, the importance of language diversity in higher education has been extensively studied, especially in the context of international students. A study by Spolsky (2012) emphasized that multilingualism in educational institutions enriches the learning environment by promoting cross-cultural communication, broadening perspectives, and enhancing cognitive flexibility. Spolsky's work suggests that when students are encouraged to use their native languages alongside the language of instruction, they can retain their cultural identity while also acquiring new linguistic skills.

Furthermore, the effectiveness of multilingual instruction also depends on the professional development of educators. Teachers must be equipped with the skills to effectively teach in multilingual classrooms where students may have varying levels of proficiency in the language of instruction. According to Gass and Selinker (2008), teacher training plays a critical role in the success of any multilingual initiative. In the context of NLP, teachers can also benefit from professional development programs that focus on how to integrate technology effectively into their teaching practices. Such training can empower educators to better support students in overcoming language barriers and provide timely, targeted feedback.

However, several scholars have pointed out the ethical considerations surrounding the integration of NLP in education. The potential biases in NLP algorithms, particularly in the context of machine translation, raise important ethical questions. As argued by Bender et al. (2021), NLP models often inherit the biases present in the training data, which can lead to discriminatory outcomes. This is particularly problematic in multilingual educational settings where the goal is to provide equal opportunities for all students. Ensuring fairness, transparency, and inclusivity in the design of NLP tools is essential to their successful implementation in educational environments. Finally, it is important to acknowledge the technological divide that may limit the widespread

adoption of NLP tools in multilingual classrooms. According to Mohan et al. (2020), the availability of technological resources, including internet connectivity and access to sophisticated NLP tools, remains a challenge in many parts of the world. To bridge this divide, institutions must invest in the infrastructure needed to support the integration of NLP in education, ensuring that all students have equal access to these technologies. The integration of multilingual instruction and NLP holds significant promise for transforming higher education. However, as mentioned in this section, the success of NLP utilization depends on addressing several challenges, including the quality of NLP tools, teacher preparedness, and the ethical considerations associated with AI. By leveraging the potential of both multilingual instruction and NLP, institutions can create a more inclusive, equitable, and effective learning environment for students from diverse linguistic backgrounds.

RESEARCH METHOD

This study adopts a mixed methods approach to investigate the impact of multilingual instruction integrated with Natural Language Processing (NLP) in higher education. This research method prioritizes the integration of quantitative and qualitative data to provide a comprehensive understanding of the phenomenon under study. (Cresswell & Creswell, 2018; Morgan, 2014). The data were obtained through a questionnaires survey, followed by classroom observations to contextualize responses.

Fifty faculty members from higher-education institutions in Jaipur, India, participated. The inclusion criteria include active teaching role and prior experience with multilingual cohorts. The participants recruitment used institutional emails and department lists. It includes random sampling which disregard institution type (public/private), discipline clusters (STEM or Social-Humanities), gender and age.

The questionnaires include six domains: (1) frequency of incorporating MLI in teaching, (2) challenge in MLI, (3) adoption of NLP tools in MLI, (4) effectiveness of NLP tools, (5) benefit observations from using NLP tools in MLI, and (6) challenge in using NLP tools in MLI. The questions are asked in the form of “yes-no questions” and multiple choices. The answers of those questions are presented in figures which later display adoption rates, perceived benefits, and reported challenges. Findings indicate frequent use of MLI, growing but uneven NPL adoption, and perceived benefits in accessibility and participation; key barriers include translation accuracy, training, and infrastructure. Meanwhile, observations were conducted to see how NLP features (live transcription/translation) facilitate participation, while accuracy issues sometimes disrupt flow.

RESULTS AND DISCUSSION

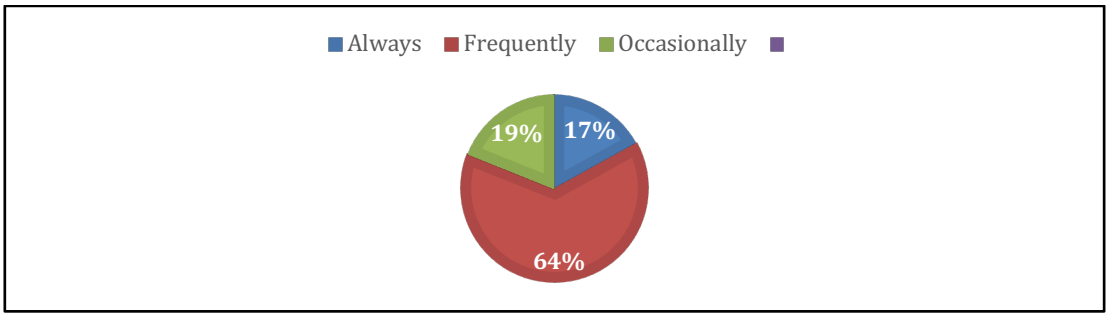
Result

The integration of multilingual instruction with Natural Language Processing (NLP) technologies has demonstrated significant potential in transforming higher education, particularly in linguistically diverse contexts. The analysis reveals that when instruction is delivered in multiple languages with the support of NLP tools, it enhances learner engagement, comprehension, and inclusivity. Students from varied linguistic backgrounds reported increased participation in classroom activities, as they could access content in their preferred language. This approach creates an equitable learning environment by addressing language barriers and accommodating the diverse needs of students. Moreover, NLP-powered tools such as automated translation and speech recognition systems simplify complex content, making it accessible to a broader audience. In terms of comprehension, the availability of multilingual resources develops a deeper understanding of academic material. Students expressed that learning in their native or familiar language alongside English enabled them to understand complex concepts more effectively. This dual-language approach encourages cognitive development by facilitating a connection between their prior knowledge and new learning. Additionally, the collaborative features of NLP tools, such as real-time translations and adaptive assessments, enable instructors to gauge student progress more accurately. These tools also provide students with immediate feedback, further enhancing their learning experience.

The survey collected responses from educators across various institutions, primarily focusing on the use of multilingual instruction and NLP tools in teaching. Most respondents had significant teaching experience, ranging from 2 to over 20 years, and a majority reported frequently incorporating multilingual instruction in their classrooms. Key challenges faced in multilingual settings included language barriers, difficulty in explaining complex concepts, limited language proficiency among students, and student engagement issues. The effectiveness of NLP tools was rated highly, with benefits such as improved language comprehension, increased student engagement, reduced language barriers, and better learning outcomes. However, challenges such as inaccurate translations, limited language support, lack of training, and technological limitations were also noted. Despite these issues, a majority of educators expressed a strong likelihood of continuing to use NLP tools in their multilingual classrooms, emphasizing their potential to enhance teaching and learning in diverse linguistic contexts.

FIGURE 1

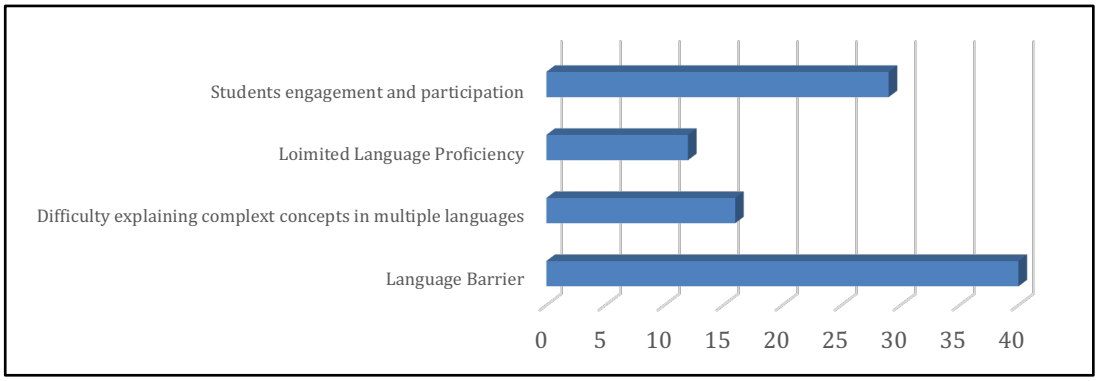
Represents frequency of Incorporating Multilingual Instruction in Teaching



Above pie chart showing the frequency of incorporating multilingual instruction in teaching. The results indicate that 64% of respondents "Frequently" use multilingual instruction, followed by 18% who "Always" incorporate it, 16% who do so "Occasionally," and 2% who "Never" include it in their teaching practices. The majority favor frequent multilingual integration.

FIGURE 2

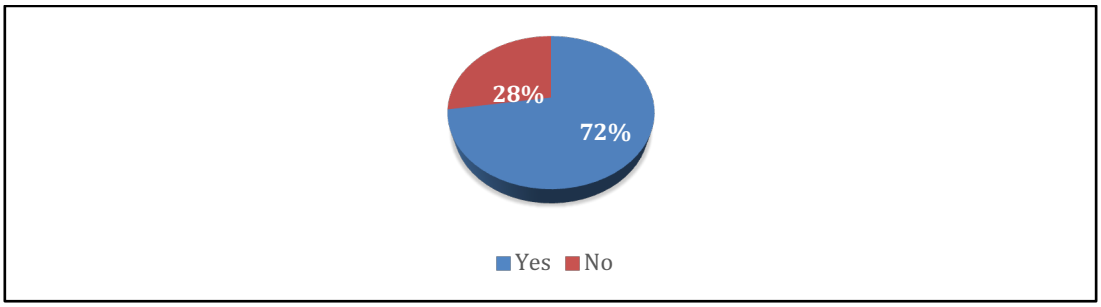
Shows challenges Faced in Multilingual Instruction



The "Language barrier" is the most prominent challenge, with approximately 40 responses, followed by "Students' engagement and participation" with 29 responses. "Difficulty explaining complex concepts in multiple languages" comes next with nearly 16 responses, and "Limited language proficiency" is the least reported challenge, with around 12 responses. The chart underscores that the language barrier and engagement issues are the most significant hurdles in a multilingual teaching context, reflecting the complexities of integrating diverse linguistic needs in higher education pedagogy.

FIGURE 3

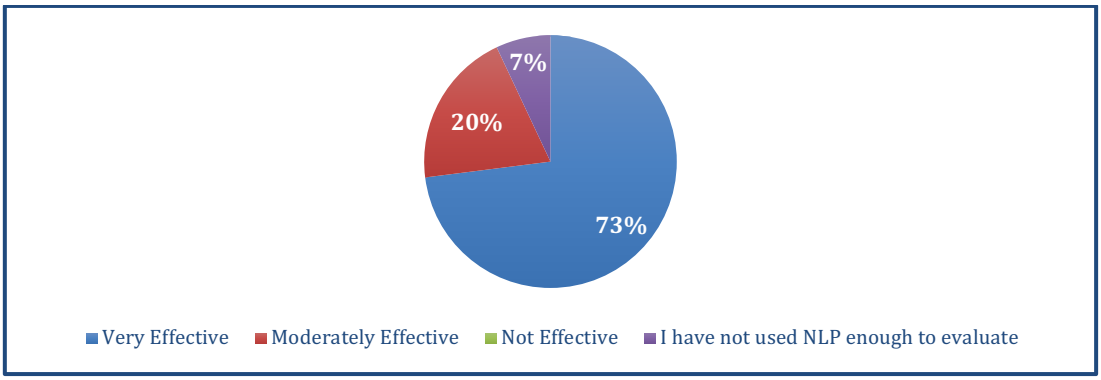
Showing adoption of NLP Tools in multilingual instruction



The chart is divided into two segments: 72% of respondents answered "Yes," indicating that they have used NLP tools, while 28% answered "No," showing they have not utilized such tools. The chart visually emphasizes the higher adoption of NLP tools in teaching practices.

FIGURE 4

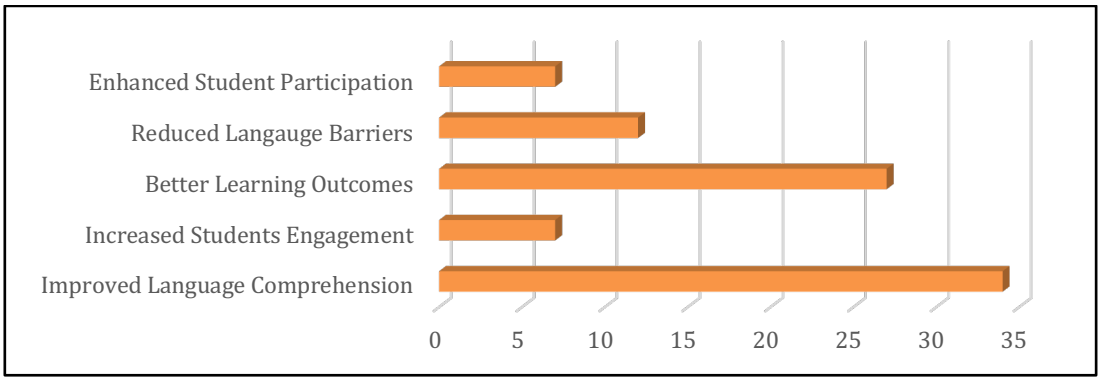
Illustrates respondents' perceptions of the effectiveness of natural language processing (NLP) tools



The largest portion, represented in blue and accounting for 73% of the chart, indicates that the majority of respondents consider NLP tools "Very Effective." The second-largest segment, shown in orange, represents 20% of participants who find these tools "Moderately Effective." A yellow segment, accounting for 7% of the chart, reflects respondents who indicated that they "Have not used NLP enough to evaluate." Notably, there is no segment for "Not Effective," implying that no respondents selected this option. The chart highlights that most users perceive NLP tools positively, with only a small fraction unable to evaluate their effectiveness due to limited experience.

FIGURE 5

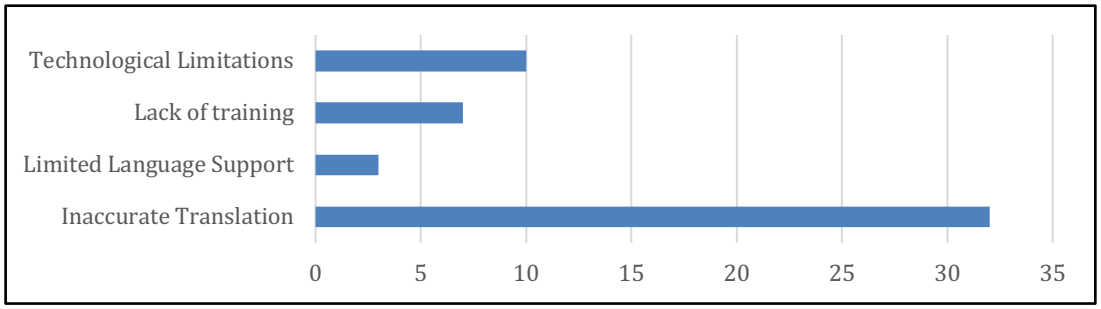
Showing benefits observed from using NLP tools in multilingual instruction



As shown in above chart, "Improved Language Comprehension" received the highest response with 35 participants acknowledging its effectiveness, followed by "Better Learning Outcomes" with 30 responses. "Reduced Language Barriers" garnered 15 responses, while "Increased Student Engagement" and "Enhanced Student Participation" were rated lower, with 10 and 5 responses, respectively. The results highlight the significant impact of this collaborative approach in improving language comprehension and overall learning outcomes, while also addressing language barriers to a moderate extent.

FIGURE 6

Represents challenges encountered by teachers while using NLP tools in multilingual instruction



Among the identified issues, "Inaccurate Translation" stands out as the most significant, with 35 respondents highlighting it as a major barrier. This is followed by "Lack of Training," which was reported by 15 respondents, indicating a substantial concern about inadequate preparation for utilizing such approaches. "Technological Limitations" was cited by 10 respondents, showcasing moderate difficulty in accessing

or utilizing the required tools. Lastly, "Limited Language Support" received the least attention, with only 5 respondents identifying it as a challenge. The results underscore the critical need to address translation accuracy and provide adequate training to ensure the effective implementation of multilingual instruction in higher education.

Discussion

The integration of multilingual instruction with Natural Language Processing (NLP) tools has demonstrated transformative potential in addressing the linguistic challenges faced by students and educators in higher education. The findings of this study reveal that the combination of multilingual pedagogy and NLP technologies significantly enhances inclusivity, engagement, and comprehension in linguistically diverse classrooms. However, the results also highlight critical challenges that need to be addressed to fully realize the potential of this collaborative approach.

One of the most significant outcomes of this study is the positive impact of multilingual instruction on inclusivity and student engagement. Educators reported that incorporating multiple languages into their teaching practices allowed students from diverse linguistic backgrounds to participate more actively in classroom discussions and activities. This aligns with the findings of Saini (2024), who emphasized that multilingual instruction fosters a sense of belonging among students by validating their native languages and cultural identities. The use of NLP tools, such as real-time translation and speech recognition systems, further amplified this effect by breaking down language barriers and enabling students to access academic content in their preferred languages. For instance, students who were previously hesitant to participate due to language constraints reported feeling more confident and engaged when they could interact with course material in their native languages. Moreover, the integration of NLP tools facilitated a more equitable learning environment. Students with varying levels of proficiency in the dominant language of instruction were able to keep pace with their peers, as NLP-powered tools provided real-time translations and contextual support. This finding is consistent with the work of Joubert and Pedersen (2019), who argued that NLP technologies reduce the cognitive load associated with language barriers, allowing students to focus on understanding the content rather than struggling with language comprehension. The ability to access lectures, readings, and assignments in multiple languages not only improved academic performance but also fostered a more collaborative and inclusive classroom culture.

The study also revealed that multilingual instruction, supported by NLP tools, significantly enhanced students' comprehension of complex academic concepts. Educators observed that students who were taught in their native or familiar languages demonstrated a deeper understanding of the material compared to those who relied solely on the dominant language of instruction. This dual-language approach allowed

students to draw connections between their prior knowledge and new learning, thereby facilitating cognitive development. For example, students who were taught scientific concepts in both English and their native language were better able to grasp abstract ideas and apply them in practical contexts. NLP tools played a crucial role in this process by providing accurate translations and contextual explanations. Automated translation systems, for instance, enabled students to access academic resources in multiple languages, while adaptive assessment tools provided personalized feedback tailored to their linguistic needs. These findings are supported by the work of Lopez (2021), who highlighted the potential of NLP to bridge communication gaps and enhance learning outcomes in multilingual classrooms. By simplifying complex content and making it accessible to a broader audience, NLP tools not only improved comprehension but also encouraged critical thinking and problem-solving skills among students.

Despite the numerous benefits, the integration of multilingual instruction and NLP tools is not without its challenges. One of the most significant barriers identified in this study is the issue of translation accuracy. Educators reported that while NLP tools were generally effective, they occasionally produced inaccurate or contextually inappropriate translations, particularly for languages with limited representation in training datasets. This limitation is consistent with the findings of Mohan et al. (2020), who noted that the quality of machine translation varies significantly depending on the language pairs involved. Inaccurate translations can lead to misunderstandings and hinder the learning process, particularly in disciplines that require precise terminology, such as science and engineering. Another challenge is the limited language support offered by many NLP tools. While widely spoken languages such as English, Spanish, and Mandarin are well-supported, less commonly spoken languages often lack adequate resources and tools. This disparity creates inequities in access to NLP-powered educational technologies, particularly for students from marginalized linguistic communities. To address this issue, there is a need for greater investment in the development of NLP models for underrepresented languages, as well as the creation of culturally sensitive tools that account for linguistic nuances and regional variations.

The study also highlighted the importance of teacher training in the successful implementation of multilingual instruction and NLP tools. Many educators reported feeling unprepared to integrate these technologies into their teaching practices, citing a lack of training and professional development opportunities. This finding aligns with the work of Gass and Selinker (2008), who emphasized the critical role of teacher training in the success of multilingual initiatives. Without adequate training, educators may struggle to effectively use NLP tools, limiting their potential to enhance teaching and learning. Technological limitations also pose a significant challenge, particularly in resource-constrained settings. Many institutions lack the infrastructure needed to support the widespread adoption of NLP tools, such as high-speed internet and

advanced computing resources. This technological divide exacerbates existing inequities in access to education, particularly for students in rural or underserved areas. To overcome these barriers, institutions must invest in the necessary infrastructure and provide ongoing support to educators and students.

Ethical Considerations

The integration of NLP tools in multilingual instruction also raises important ethical considerations. As noted by Bender et al. (2021), NLP models often inherit biases present in the training data, which can lead to discriminatory outcomes. In the context of education, biased algorithms may reinforce stereotypes or marginalize certain linguistic groups, undermining the goal of creating an inclusive learning environment. To address this issue, it is essential to develop ethical guidelines for the use of NLP in education, ensuring that these tools are designed and implemented in a fair and transparent manner.

Future Directions

The findings of this study underscore the need for continued research and innovation in the field of multilingual instruction and NLP. Future studies should explore the long-term impact of these technologies on student outcomes, as well as the development of more accurate and culturally sensitive NLP models. Additionally, there is a need for greater collaboration between educators, researchers, and technology developers to ensure that NLP tools are aligned with the needs of diverse learners. Institutions must also prioritize the professional development of educators, providing them with the skills and knowledge needed to effectively integrate multilingual instruction and NLP tools into their teaching practices. This includes training on how to use NLP technologies, as well as strategies for fostering an inclusive and culturally responsive learning environment.

CONCLUSION

In conclusion, this collaborative approach presents a promising approach to enhancing teaching and learning in higher education. The findings from this study underscore the significant benefits of multilingual pedagogy in fostering inclusivity, improving student engagement, and enhancing comprehension across diverse linguistic backgrounds. NLP tools have proven to be highly effective in simplifying complex academic content, facilitating real-time translations, and providing personalized feedback, thus supporting students' cognitive development. However, the study also

highlights several challenges, including issues with translation accuracy, limited language support, and a lack of proper training for educators. Addressing these challenges through enhanced teacher training, technological improvements, and better customization of NLP tools is essential for maximizing their potential. Institutions must also continue to evaluate and refine the integration of multilingual instruction, ensuring that it remains a core aspect of curriculum design and pedagogical strategies. Ultimately, the combination of multilingual instruction and NLP tools has the potential to transform the learning experience, making education more accessible and equitable for all students, regardless of their linguistic background. Continued investment and development in these areas will play a key role in shaping the future of education in linguistically diverse settings.

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