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Facilitating Translingual Practices in Multilingual STEM Classrooms to Bridge Content and Language Gaps

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Abstract: Multilingual classes are very challenging in STEM education, where students must learn and understand the content as well as learn language. This paper discusses the content and language gaps in Grade 8 students in a multilingual setting in Tamil Nadu, India, and how these gaps can be addressed through translingual practices. The methodology followed was a qualitative case study, which entailed a classroom observation, interviews, questionnaires, and lesson recording. According to the results, 82 % of the students reported an improvement in their conceptual knowledge and 78 % reported an improvement in classroom participation by being given the opportunity to use many languages. The visual scaffolding and local language explanations of the teachers also contributed to higher levels of understanding and interaction. However, such problems as the resistance of the institution and lack of formal training were actualized. The results of the research suggest that translingual pedagogy is quite effective in improving STEM learning and inclusive education. It proposes the integration of systematic translingual practices of teaching and policymaking as a means of responding to the needs of the multilingual learners. This study points out that translingual practice has been shown to decrease cognitive load as it allows the students to relate the previously acquired linguistic information with the newly acquired academic information thus helping students to understand the material better. The results also reveal that the level of collaboration with peers also grew as the students were given a chance to speak their native language when solving problems. Visual aids and interactive discussions that were incorporated in the multimodal teaching techniques enhanced the development of language and clarity of the concepts. These results highlight the need to implement multiflexible and welcoming pedagogical methods in multilingual STEM classes.

Key Words: translingual practices, multilingual education, stem learning, language and content integration, classroom pedagogy, student engagement, inclusive education.

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Introduction

The situation of the increased linguistic diversity of classrooms everywhere in the world and, in particular, in the multilingual countries such as India has radically transformed the landscape of education. Different linguistic repertoires are introduced by students into classrooms, posing a challenge and opportunity to teaching and learning. In science, technology, engineering, and mathematics (STEM) teaching, where the conceptual knowledge is tightly linked with the specific vocabulary, such a variety often leaves the gaps not only in the content knowledge but also in the language knowledge. The challenge of acquiring multifaceted scientific concepts in the situation of teaching in a dominant language is a pressing pedagogical problem of learners in multilingual settings (Mouboua et al., 2024).

Language barriers in STEM learning are not only a linguistic issue; also cognitive since the students are required to simultaneously learn and comprehend the content of the subject and new vocabulary. The studies indicate that these two demands could be an obstacle to effective learning and participation,

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especially when such students fail to master the medium of instruction (Tripp & Waight, 2024). The conventional monolingual teaching approaches, whereby there is concentration on a single standard language, are not sufficient when it comes to appreciating the dynamic connection in the linguistic resources that multilingual students possess. This is dissociative in terms of classroom practices and lived linguistic realities of students (Melo-Pfeifer, 2024).

Translingual practices have become a new emerging pedagogical approach to solve these issues. Unlike the hard language separation models, translingual practices endorse the multi-faceted utilization of at least two languages to form meaning, and the learners are able to use all their linguistic resources (Lemmi & Pérez, 2024). These activities facilitate greater learning, increase conceptual knowledge, and foster inclusion in learning environments in STEM classrooms (Wong & Tian, 2025).

Although there is increased interest, there is a gap between theoretical support of translingual approaches and practical application in STEM education. The majority of teachers lack the training as well as the confidence to enforce such strategies in an effective manner, and even institutional policy tends to remain with monolingual norms (Kim et al., 2025). The proposed research will cover this gap by taking into account how translingual practices can optimize the efficiency of combining the content and language learning in multilingual STEM classes.

The objectives of this research are:

- To explore how translingual practices can be used to enhance knowledge in STEM.
- To find out issues encountered by multilingual students in STEM classes.
- To explore positive methods of implementing translingual learning.

Paper Organization:

The structure of the paper will be as follows: Section 2 will consist of a literature review concerning multilingual education and translingual practices in STEM; Section 3 will be the theoretical framework; Section 4 will be the description of the methodology; Section 5 will dwell upon the findings and analysis; and the conclusion with implications and recommendations will be presented in Section 6.

Literature Review

Some of the factors contributing to the increased prevalence of multilingual classrooms are globalization and multiculturalism of the world, particularly in countries such as India. These classrooms are made up of students who use more than one language in their daily lives, and a richness of language is brought into the classroom learning experience. However, the traditional education systems are likely to adhere to a single language of instruction and therefore cast out the multilingual students and limit their interactions (Melo-Pfeifer, 2024). As it has been discovered, students in such settings are able to feel less engaged and not a part of the group in case their linguistic identities are not acknowledged (Tripp & Waight, 2024). Also, teachers are not typically ready to address the issue of linguistic diversity that, once again, impacts the learning outcomes (Kim et al., 2025).

There are some challenges of STEM education with multilingual learners due to the application of technical language and abstract ideas. The science lingo is vastly different from the everyday language and is difficult to comprehend and to express (Mouboua et al., 2024). This gives a twofold load where the students not only need to process the content knowledge but also language, which is often referred to as

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cognitive and linguistic load. Studies also indicate that the students are able to learn the concepts in their mother language, yet not able to explain them in the language of instruction (Wong & Tian, 2025). Furthermore, the application of symbols and language pertaining to discipline in other subjects like mathematics and science complicates learning even more (Marshall et al., 2023). These difficulties may have a detrimental impact on the students with no proper linguistic assistance (Fine et al., 2025).

Translingual activities involve a dynamic and flexible approach to two or more languages to assist in creating meaning. This approach transcends the traditional code-switching in that it integrates language resources, unlike the consideration of languages as different systems (Sun & Canagarajah, 2025). The translingual practices are based on the sociocultural theory according to which language is regarded as a way of learning and cognitive development. These activities help students to use all of their linguistic repertoire in the STEM classes and understand more complex concepts and be more engaged in the educational process (Lemmi & Pérez, 2024).

The other translingual pedagogical approaches can be multimodal regimes of visual aids, gestures, and digital tools to facilitate comprehension. As an indicator, a conceptual and interactive learning setting with the integration of technology-based scaffolding was discovered to enhance participation and conceptual learning among multilingual students (Ding et al., 2025). Those strategies make it easier to be inclusive and assist students in bridging the language-content gaps.

The recent studies underline the applicability of translingual practices to the improvement of the outcomes of STEM education. Surveys show that multilingual teaching methods have the ability to overcome language and content differences and yield high academic outcomes (Mouboua et al., 2024). Research done in classrooms shows that students benefit by using their first languages with the language of instruction, which enhances engagement and understanding (Lemmi & Pérez, 2024).

Translingual practices help to make learning inclusive, and students have a sense of belonging (Tripp & Waight, 2024). Teacher training in strategies of translanguaging has been found to positively influence teachers in regards to their teaching behaviors as well as their overall attitude towards students who are multilingual (Venegas-Weber et al., 2024). Diverse learners, including learners with special needs, are further supported by innovative techniques, e.g., multimodal and interdisciplinary techniques (Scott & Cohen, 2023).

Nonetheless, there are still issues with implementing these practices. The ideologies of the instructors, lack of training, and institutional binding are more likely to hinder the implementation of the translingual pedagogy (Fine et al., 2025; Kim et al., 2025). Moreover, although the potential is also indicated in the current research, it remains necessary to conduct more practical and contextual studies, particularly in STEM classrooms (Ding et al., 2025).

Overall, the literature suggests that, despite the fact that multilingualism may be an issue when it comes to STEM education, translingual practice may offer solutions to the issues. However, further studies are needed on how this can be practically implemented and supported by teachers, which is being attempted by the present study.

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Methodology

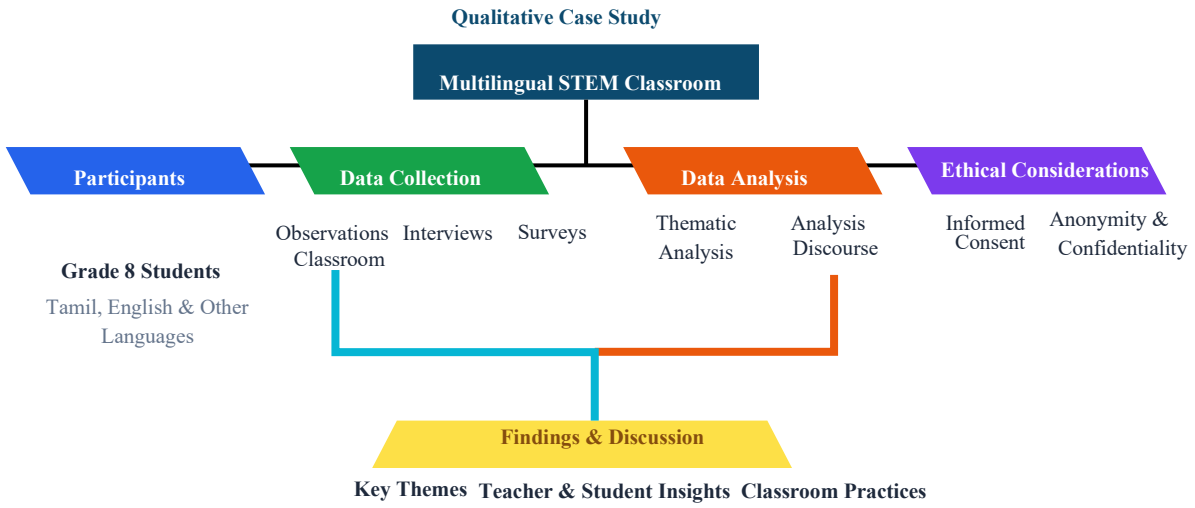

Figure 1: Research Methodology Framework for Translingual Practices in Multilingual STEM Classrooms

The overall approach in this research is depicted in figure 1. It offers a qualitative case study that occurs in a multilingual STEM classroom and describes some of the key elements, such as the participants, process of data collection, data analysis techniques, and ethical considerations. The diagram shows the procedure of the data collection, which included classroom observations, interviewing, surveys, and recording of the lesson, and the data, which were analyzed with the help of thematic and discourse analysis. It also lays emphasis on such ethical issues as informed consent and confidentiality. The flow of the figure shows how the following related phases lead to the formulation of findings and discussion to give a full picture of translingual practices in STEM education.

Research Design

The qualitative case study design is assumed in this research paper in order to comprehend the importance of the translingual practice in multilingual STEM classes. The qualitative method is also appropriate as it allows one to learn about the dynamics within classrooms, how languages are employed, and how meaning-making processes of multilingual learners are developed in-depth. The case study approach assists the researcher to observe naturally occurring teaching-learning practices that occur in a real classroom and the intersection of language and content in teaching STEM.

It is qualitative research, which attempts to describe the experiences and perceptions of the study participants and classroom interactions in comparison with the necessity to statistically generalize the findings. This method is especially applicable to the research of complicated educational phenomena like translingual pedagogy, in which context is an important factor.

Participants

The study was conducted at a school in Tamil Nadu, India, that is multilingual. The participants included: Students: Grade 8 students (around 30) were chosen. The students represented a wide range of languages, including Tamil (as a native language), English (as a language of instruction), and varying degrees of exposure to other languages in the area. Most of the students were multilingual, with Tamil as their language at home and English at school, with different levels of proficiency.

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Teachers: Two STEM teachers (science and mathematics) participated in the study. Both teachers had experience teaching in multilingual classes, yet neither received any training in translingual pedagogy. Their teaching experiences provided valuable insights into how language can promote or inhibit STEM education.

The participants were selected using purposive sampling to make sure that multilingual learners and teachers that are actively engaged in teaching STEM were represented.

Data Collection Methods

Data collection could have been done in a number of ways to ensure that there was triangulation and a high level of validity of results:

Classroom Observations: There was a four-week cycle of classroom observations. These were observations that involved the use of language, teacher-student interactions, and methods used to explain STEM concepts. Field notes were maintained to note significant happenings and trends.

Interviews: Semi-structured interviews were conducted with the teachers and the selected students. In interviews with teachers, their vision for using language to teach STEM, their challenges, and the methods they employ were discussed. Interviews with students were targeted at learning experiences, language preferences, and difficulties encountered.

Surveys: A short survey was created to gather additional data on students' language backgrounds and perceptions of language use in classrooms, as well as their perceptions of the obstacles to learning STEM.

Lesson Videos: The selected lessons were recorded, and the tapes were made of real-life classroom discourse. These recordings provided some information to examine how translingual was implemented in the teaching.

Data Analysis

The data collected was analyzed in terms of the thematic analysis and discourse analysis. Thematic analysis was used to identify general patterns and themes related to language use, student participation, and conceptualization. The data, in the form of observations, interviews, and surveys, were coded and divided into broad themes, such as language support, student engagement, and clarity of concepts.

The discourse analysis of the language used in real-time interactions was conducted through classroom recordings. This was coupled with the study of code-switching and of multimodal and multilingual methods of communication. The combination of the strategies offered the possibility to develop an in-depth understanding of how translingual practices in STEM classes work.

Ethical Considerations

During the study, ethical guidelines were adhered to. The school authorities, teachers, and students were informed and gave their consent prior to the data collection. Parents/guardians also consented in the case of small participants.

The participants were guaranteed confidentiality and anonymity, and the findings were given out using pseudonyms. All data stored were in a secure place and utilized in academics. Moreover, special care was taken to ensure participation was voluntary, and participants were free to withdraw from the study at any time without repercussions.

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Findings and Discussion

The observations and interviews in the classroom, along with the videotaping of the lessons, revealed that there were several key patterns in the role of translingual practices in multilingual STEM classes. The findings are summarized into four big themes, that is, better conceptual knowledge, higher engagement, issues of teacher practices, and implementation.

Improved Conceptual Understanding

The results show that translingual activities have a significant impact on students' conceptual knowledge in STEM subjects. Students who had the opportunity to use their home language and those who had the opportunity to use the medium of instruction had a better understanding of more complex scientific and mathematical concepts. During the classroom observation, it was observed that students were inclined to learn concepts in their native language and then translate them into English, thereby reducing cognitive load and learning more. This interaction in two languages served to bridge the gap between the knowledge already possessed and the new academic content, enabling students to acquire abstract concepts more effectively.

Increased Participation

The study also showed a significant increase in the number of students who participated in the study as linguistic flexibility was encouraged. Students who used to be shy about speaking English in the classroom gained confidence to participate in classroom activities when had the opportunity to use more than one language. This led to greater involvement, socializing, and collective problem-solving. The classroom was more inclusive, with students no longer afraid to share their ideas or language mistakes, resulting in better communication and learning outcomes.

Teacher Strategies

The teacher was very critical in helping in the translingual practices since taught them with powerful approaches to teaching. The most common ones were the use of local language, explanations of complex STEM concepts, and their translation into English. Also, teachers used visual aids such as diagrams, charts, and real-life examples, as well as multilingual scaffolding, to aid understanding. These multi-modal teaching methods helped students connect language to the content, making it more comprehensible and memorable, and motivating active learning, as shown in table 1.

Table 1: Student Responses on Translingual Practices

Statement	Agree (%)	Neutral (%)	Disagree (%)
Helps in understanding STEM concepts	82%	10%	8%
Increases classroom participation	78%	12%	10%
Reduces difficulty in technical vocabulary	75%	15%	10%
Makes learning more engaging	80%	11%	9%

Challenges

Although it has some benefits, implementing translingual practices encounters a number of challenges. The institutions where most schools continue to use the monolingual teaching approach still provide significant resistance, thereby limiting teachers to teaching only one language. Moreover, teachers are not trained in translingual pedagogy, which prevents them from using these strategies effectively and systematically. Other restrictions, such as rigid curricula and time constraints, only add to the complexity

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of integrating language-inclusive approaches, indicating the need for policy support and professional development.

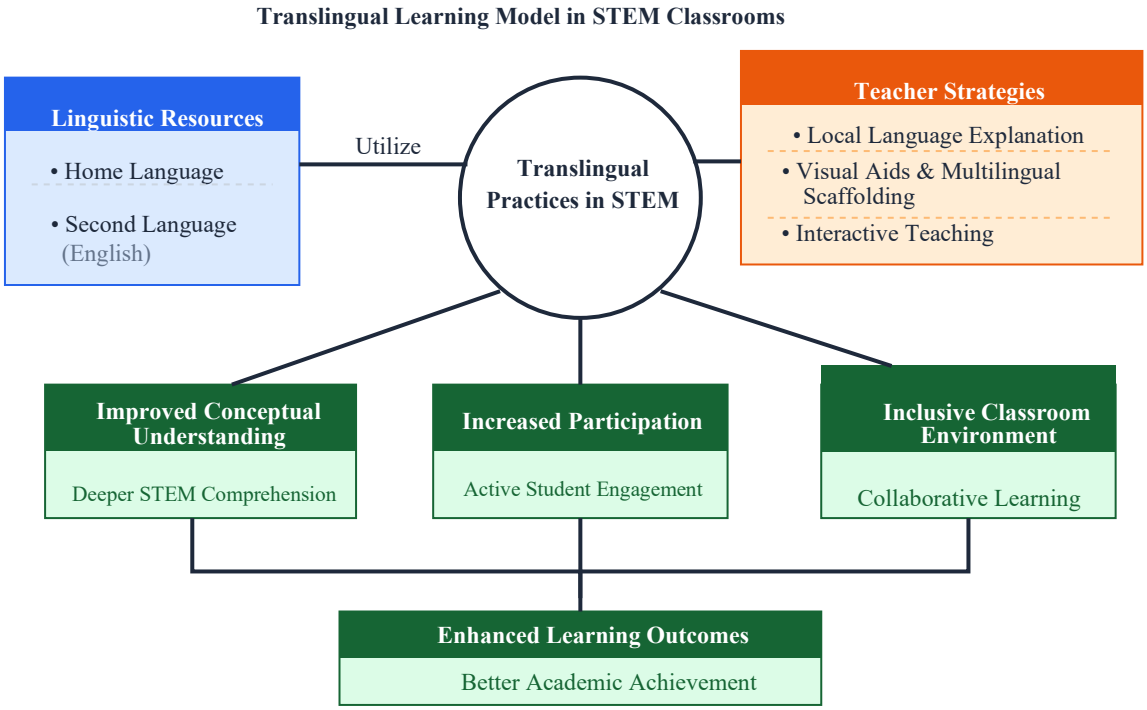

Figure 2: Translingual Learning Model in STEM Classrooms

The translingual model of learning in figure 2 concerns how the linguistic resources of students, teacher strategies, and learning outcomes interact. It demonstrates how multilingualism, together with the assistance of visual aids and scaffolding techniques, can lead to a better conceptual learning process, a more active classroom, and a more inclusive classroom.

Discussion

The findings of this study show that translingual practices are a key element in bridging the gap between language and content learning in multilingual STEM classrooms. The results also show that allowing students to use their full linguistic repertoire should not only support conceptual understanding but also enhance involvement and engagement. The local-language explanations and use of multilingual scaffolding are directed toward increased understanding, which is also consistent with recent educational theories, in which language is seen as a tool rather than a hindrance. Nevertheless, the lack of institutional support and the continued use of institutional barriers indicate that the effective use of translingual pedagogy must be supported at the systemic level. Overall, the study supports the relevance of inclusive instructional strategies that integrate language and content to foster equitable, fruitful STEM learning.

Conclusion

This research proves that translingual practices are significant in promoting STEM education in multilingual classrooms, as create a good gap in the content and language areas. The results show that 82% of students had better conceptual understanding and 78% felt more involved when linguistic flexibility was integrated in the classroom teaching. These results highlight the importance of relying on students' linguistic resources better to support their understanding and interaction in the learning process. The

informal use of multilingual scaffolds and local-language explanations by teachers was found to be highly effective in the learning process, as most teachers were not trained in their application. The benefits, the study has also identified major concerns, such as the institutional bias toward teaching monolingualism and the absence of professional development opportunities for teachers. These are but a few challenges that limit the application of translingual pedagogy in STEM learning. Policy-level support and specific teacher training programs, therefore, are in demand to support the adoption of inclusive teaching practices. It is significant that further research is needed on the long-term consequences of translingual strategies for academic achievement and on their applicability across different learning environments and grade levels. Using multilingual technologies may also be a new avenue towards enhancing STEM learning outcomes. Future research ought to be based on longitudinal studies that can be used to determine the long-term effects of translingual practices on the achievements and language growth of students. Also, it is possible to perform experimental studies to compare translingual strategies with traditional monolingual ones in various STEM subjects. The application of digital tool to improve classroom interaction and accessibility can also be discussed through integration of digital tools like multilingual learning and AI-assisted translation. Future research can also explore teacher training models to come up with systematic models of applying the translingual pedagogy effectively in various educational settings.

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