

Research Article

Translanguaging and Conceptual Clarity: Indian Science Teachers' Critical Reflections on Multilingual Pedagogy

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Language hierarchy and the choice of the medium of instruction (MOI) pose significant challenges in Indian multilingual classrooms. Monolingual approaches to MOI should be replaced with translanguaging, which recognizes students' home language(s) as a resource for language and content learning. In content subjects like science and mathematics, translanguaging can create an enjoyable learning atmosphere and enable knowledge-building in the classroom. This study investigates science teachers' perspectives on translanguaging and its impact on students' conceptual understanding. The study involved five science teachers working in English-medium high schools in Telangana, India. Data collected through semi-structured interviews were analysed adopting a reflexive mode of thematic analysis. The analysis

presents patterns of translanguaging moves of the science teachers to aid student learning of scientific concepts. Alongside this, the researcher's reflexivity is used so that subjectivity becomes a tool for interpreting the data and establishing the positionality of the researcher. The study identified that the five science teachers observed conceptual understanding as an important aspect of the science classroom, and to facilitate it, they opined that they actively used translanguaging strategies in their classrooms. The study is expected to further translanguaging research in India, especially in content classrooms and bring to the fore teachers' perspectives on the role and utility of translanguaging practices in promoting conceptual clarity among students.

Keywords: bi/multilingual education; English Medium Instruction; science classrooms; teacher perceptions; translanguaging

1. INTRODUCTION

Bilingual/multilingual educational practices are common in multilingual countries like India. However, a growing concern is the current demand and increase in English medium instruction (EMI) in education in such multilingual countries. Macaro (2018) defines EMI as the use of the English language to instruct subjects other than English in non-English speaking countries. Therefore, it is inevitable that a pedagogical approach robustly supporting the educational language practices in multilingual countries is necessary to address the challenges that the EMI-only model brings. Students' knowledge acquisition in EMI classrooms can be enhanced by incorporating their home language(s) to support content learning. According to Lemmi and Perez (2023), A simplistic view of multilingualism treats language switching as a deficiency rather than a natural skill of multilingual teachers and learners. In contrast, translanguaging mirrors bi/multilingual skills drawing upon one's entire linguistic repertoire and is found to be

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commonly used by teachers and learners for academic as well as socio-communicative purposes in the school context (Lightfoot et al., 2021). Translanguaging recognizes students' home language(s) as a significant linguistic and cultural resource in the classroom that can be employed to facilitate language as well as content learning (Liu & Fang, 2022; Mukhopadhyay, 2020).

In the Indian context, there are several studies investigating teachers' translanguaging practices in typical EMI classrooms (Anderson, 2022; Anderson & Lightfoot, 2018; Bisai & Singh, 2019; Mukhopadhyay, 2020; Sah & Kubota, 2022; Vaish, 2019; Lightfoot et al., 2021). A significant research study exploring language use and performance of multilingual learners in concept-based classrooms is the recently conducted MultiLiLa project (Tsimpli et al., 2020). It recommends using language(s) other than the medium of instruction (MOI) for concept learning and application in maths and other academic subjects. This is because it can foster better learning and understanding in English textbooks mediated through home languages. However, research also identifies that the effective implementation of translanguaging as a tool and its impact on learning outcomes require more systematic exploration (Fang et al., 2022).

In line with the above-mentioned background, there is a lack of research in India on the translanguaging practices of teachers and their perceptions of its use in content subjects such as science and mathematics. These subjects require conceptual understanding, and a significant challenge can be teachers' language practices in multilingual classrooms. Also, the students may not be proficient in English as a language of communication and/or instruction. This research study is one of the first attempts to investigate Indian science teachers' translanguaging practices, their perceptions of using translanguaging and its impact on their multilingual students' conceptual clarity in these subjects. It adopts translanguaging as a pedagogical model to analyze the language practices of science teachers in their classroom interactions. It also focuses on the concept of 'understanding' that plays an important role in the science classroom teacher practices and students' knowledge acquisition, which is intertwined with the languaging practices in a multilingual classroom and is yet underexplored.

2. PEDAGOGICAL TRANSLANGUAGING

Garcia (2011) defines translanguaging as 'multiple discursive practices' used by bilinguals to 'make sense of their bilingual worlds,' and it goes beyond code-switching practices. Probyn (2018) defines pedagogic translanguaging, a sub-type of translanguaging that this study adopts for analysing teacher practices, as the purposeful and systematic use of the learners' home language(s) instead of the reactive and brief code-switching or neglect of the learners' home language(s) in class. Pedagogic translanguaging emphasizes multilingualism based on the concept of the full linguistic repertoire of multilingual speakers and their social context. It acknowledges the nature of language as a separate entity but identifies that they are flexible and accommodating

(Cenoz & Gorter, 2020). Studies show that translanguaging fosters collaborative discussions in multilingual science and mathematics classrooms (Charamba, 2020a) and promotes knowledge construction and meaning-making through multimodal and multilingual resources, creating an inclusive environment for linguistically and culturally diverse students to participate in semiotic and discursive practices (Tai, 2022). It also allows multilingual students to practice representing their knowledge of scientific explanations as they understand it, resulting in higher academic achievements (Charamba, 2023). Therefore, translanguaging as a pedagogical tool in the science classroom can facilitate better knowledge co-construction, helping the students navigate through complex concepts using their language(s) and build an understanding of the language and concepts of science. Exploring teacher practices and perceptions of translanguaging as a pedagogical tool in Indian science classrooms will promote better languaging practices to support scientific knowledge construction and conceptual understanding among the students.

Baumberger et al. (2017) state that curricula in universities and schools time and again consider understanding or comprehension to be one of the main goals of training and education. Perkins (1994) defines understanding a topic as the ability to perform a variety of ‘thought-demanding’ tasks such as explaining, finding examples, gathering evidence, representing, generalizing, analogizing, and applying the concepts, and many more, about the topic as against rote learning that disregards these practices. He defines these as ‘understanding performance’ or ‘performances of understanding’ (p. 42). Newton (2011) argues that understanding can change our thinking, make us less susceptible, and enable us to look through different points of view; all this takes time and effort for the teachers and students and hence can easily fall into the background. Widiyatmoko and Shimizu (2018), in the context of science education curriculum in Indonesia, state that knowledge competence or understanding is one of the core competencies of all educational levels and subjects, and conceptual understanding is an integral part of and a basic competency in learning science concepts.

Conceptual understanding in science involves integrating prior knowledge with new concepts (Banda & Nzabahimana, 2021). The existing literature emphasizes the role of conceptual understanding in science education and the several approaches teachers adopt to build learners’ understanding. However, the role of teachers’ languaging practices in developing the understanding of the basic concepts of science and the role of translanguaging in multilingual classrooms to facilitate scientific understanding is underexplored in the Indian context. Investigating teacher practices to build understanding through translanguaging is likely to improve language practices for knowledge construction in science classrooms that this study attempts as a novel area of research. It investigates the usefulness of translanguaging in science classrooms for secondary education in India.

3. SCIENCE TEACHERS' TRANSLANGUAGING PRACTICES

Despite a drastic increase in the demand for EMI in several countries, teachers' and students' practices investigated in research are positively aligned towards translanguaging. Though there is an English-only rule in several educational institutions, teachers actively try to accommodate the students' home language(s) in their science classrooms (Tsimpli et al., 2020). Kääntä et al. (2018) investigated the content and language-integrated learning (CLIL) practices of two teachers in a physics classroom. They reported that the teachers actively employ multimodal and multilingual practices in the classroom to conceptualize and define the concepts in physics. Pun and Tai (2021) explored the language practices of grade 10 students and teachers of a Hong Kong EMI secondary school and reported that both the teachers and students engage in translanguaging practices, with the use of L2 English, Cantonese (L1) and English jargon to create a playful conversation. Licona and Kelly (2019) investigated the translanguaging practices of teachers and students in an English/Spanish dual language classroom in an urban middle school science classroom. They identified that translanguaging facilitates more manageable academic tasks, maintains the classroom culture, and develops epistemic practices. Lu and So (2023) identified that science teachers use translanguaging along with other teaching strategies, such as explanatory strategies to give examples, repetition, and synonyms to strengthen and clarify the concepts being taught. Charamba (2022) investigated the translanguaging practices of three teachers at a secondary school and found that the teachers used collaborative learning strategies and supported the students in using their linguistic repertoires in the group activities. Tai (2022) explored the translanguaging practices of science and maths teachers in a secondary school in Hong Kong and reported that the teachers switched between English and Cantonese to facilitate learning in these classrooms. Infante and Licona (2018) investigated an English and Spanish science classroom, examining the teacher and student translanguaging practices, and identified that the teacher used language in the classroom in response to the student's linguistic needs as the goal was to promote learning despite the language barriers. Garza and Arreguin-Anderson (2018) explored the translanguaging practices of a fourth-grade science teacher. They found that the teacher encouraged scientific literacy using multimodal formats such as reading, speaking, and writing visual aids, intonation, and gestures to understand a science text. The above-mentioned studies report and emphasize that teacher practices in science classrooms promote students' engagement, argumentation skills, classroom interactions, participation, and understanding of scientific concepts and bridge the difference between the students' first or home language and the classroom language. Therefore, exploring the science teachers' languaging practices in the Indian classroom will similarly inform the translanguaging functions and the challenges they face in leveraging its use as a multilingual pedagogical tool to increase conceptual clarity amongst young students. Table 1 below lists the translanguaging strategies and purposes used by the teachers, and the frequency of their occurrence as found in the above-mentioned studies.

Table 1. Comparison of Translanguaging Strategies

| Translanguaging Strategies | Purposes | Frequency of Use | Studies |
|--|---|-------------------------|--|
| Bridging scientific/academic language with learners' everyday language | Translating scientific and mathematical terminology using learners' everyday language | High | Charamba (2022), Infante and Licona (2018), Kääntä et al. (2018), Lu and So (2023), Pun & Tai (2021), Tai (2022) |
| Formulating scientific argumentation | Helping the students build evidence, claims and reasoning using bilingual resources | High | Garza and Arreguin-Anderson (2018), Infante and Licona (2018), Lu and So (2023), Pun & Tai (2021) |
| Using multimodal resources | Using visual aids, objects and gestures alongside translanguaging | High | Charamba (2022), Garza and Arreguin-Anderson (2018), Kääntä et al. (2018), Pun & Tai (2021), Tai (2022) |
| Facilitate peer collaboration | Encouraging students' discussions in their first language to facilitate subject understanding and clarity | Medium | Charamba (2022), Garza and Arreguin-Anderson (2018), Lu and So (2023), Pun & Tai (2021) |
| Using bilingual resources | Teaching aids in multiple languages to scaffold understanding | Medium | Charamba (2022), Garza and Arreguin-Anderson (2018), Tai (2022) |
| Code-switching practices | Alternating between languages to clarify and explain concepts | Low | Charamba (2022), Garza and Arreguin-Anderson (2018), Kääntä et al. (2018), Lu and So (2023), Pun & Tai (2021) |
| Linguistic and cultural contextualization | Using linguistic and cultural contexts to relate scientific and mathematical concepts | Low | Charamba (2022), Garza and Arreguin-Anderson (2018) |
| Student-led translanguaging practices | Encouraging students to use multiple languages to explain concepts | Low | Garza and Arreguin-Anderson (2018), Licona and Kelly (2019) |

4. TEACHER PERCEPTIONS OF THE IMPACT OF TRANSLANGUAGING IN CLASS

Few research studies have explored science teachers' perceptions of translanguaging practices in their classrooms. Furthermore, in the existing research, teacher perceptions about science classrooms are often reported as practices. Charamba (2020b) investigated the perceptions of six primary school teachers in South Africa. The classroom observations in the study revealed that the teachers use the students' home language(s) to explain the concepts. The teacher participants perceived that the underachievement in the science classrooms was due to a lack of proficiency in the MOI (English), and using translanguaging strategies would improve students' participation and enhance their academic performance. Rahman and Singh (2022) investigated STEM students' and teachers' language ideologies of translanguaging at an EMI private university in Bangladesh. Interviews with the students and teachers revealed that translanguaging is used in STEM classrooms for communication, meaning-making, and the construction of knowledge in scientific concepts. The teachers stated the need for such practice to deliver the content effectively. Karabassova and San Isidro (2023) investigated teachers' perceptions in a CLIL classroom in Kazakhstan and found that teachers' perceptions of translanguaging were somewhat ambiguous; translanguaging was considered a temporary practice for scaffolding content and a way to address the teachers' limitations of language proficiency in the instructional language, English.

Teacher perception studies of translanguaging in India and other multilingual countries in the EMI, EFL, CLIL, and ESL classrooms reveal that teachers understand the role of utilising students' home language(s) in education; however, teacher translanguaging practices were hindered due to the institutional restrictions imposed or the teachers' lack of English proficiency. Research conducted by Anderson & Lightfoot (2018) on 169 Indian teachers' practices and attitudes toward translanguaging reveals that only a few teachers use translanguaging actively, and the rest of them make occasional use of the mother tongue in EMI classrooms for comparing and contrasting the features of languages, translation and explaining of concepts and managing the classrooms. Cenoz et al. (2022) explored the relationship between pedagogic translanguaging and teachers' and students' perceptions of communicative anxiety (communicating in multiple languages other than the medium of instruction in this context). They indicated that pedagogic translanguaging reduced teachers' guilt and students' anxiety about using other language(s) in the classroom. Yuvayapan (2019) investigated the English language teachers' (EFL) translanguaging practices and perceptions at private and state schools in Turkey and identified that though the teachers had positive perceptions of translanguaging practices, their perceptions do not align with their practices, due to the restrictions posed by their colleagues, institutions, and parents of the students of the school. Kumpulainen (2023) reports that although the teachers in CLIL classrooms had positive attitudes towards translanguaging, monolingual attitudes also existed. Vaish (2019) identified that diverse language backgrounds in multilingual classrooms make it

challenging to implement translanguaging pedagogy. The lack of teachers' reflective practices was also found to be a hindrance (Mukhopadhyay et al., 2023).

Therefore, besides acknowledging translanguaging as an effective pedagogical tool in multilingual classrooms, it is necessary to explore the challenges in its effective implementation. Also, the vast literature on the impact of translanguaging and teachers' practices, perceptions, and challenges often focuses on English language classrooms. Concept-based subject classrooms are underexplored in India-based research on translanguaging, though language(s) of instruction is in constant interplay with the concepts. Exploring Indian science teachers' perceptions of the impact of translanguaging on developing conceptual clarity in science classes will better inform languaging practices in science and, by implication, other content classes.

5. IMPACT OF TRANSLANGUAGING ON STUDENTS' CONCEPTUAL CLARITY

Investigating the impact of translanguaging on the student's conceptual clarity is a fairly new area of research and has few studies to contribute to our understanding. Current research focuses on how translanguaging practices create a space for students to use their languages in the academic setting to make meaning of the scientific concepts for knowledge construction and actively participate in the classroom. A 'translanguaging science classroom' (TSC), where the students engage in a dialogic activity with the other students to explain and discuss the concepts in their home language(s), is an asset in building a new 'social practice' for the students who cannot express themselves and understand the subject in the language used as the medium of instruction (such as EMI) in the classroom (Karlsson et al., 2019). Translanguaging positively impacts academic achievements in both language proficiency and content learning. Through translanguaging as a linguistically sensitive approach, students can build their conceptual understanding of science education, relating it to linguistic practices outside the classroom (Infante & Licona, 2018). Poza (2018) explores classroom activities such as oral presentations, vernacular language use in writing, discussions, and debates on word choice in both Spanish and English in the science classroom and lists the practical use of translanguaging for achieving academic skills like understanding complex texts with visual aids, learning technical vocabulary, and categorizing objects with similar characteristics.

According to Lu and So (2023), besides knowledge construction, translanguaging in science classrooms builds a space for the teachers and students to facilitate inquiry into scientific activities by creating an enjoyable environment and negotiating directions. Charamba (2019) investigated the impact of translanguaging practices on the academic achievement of 40 eleventh-grade students in their physics classrooms. The study involved a pre-test with English as the language of instruction and a post-test with both English and Sesotho. It was observed that the learners' became more confident using

both languages and linked their improved academic performance to bilingual learning materials and translanguaging practices. Translanguaging can facilitate new learning methods in a STEM (science, technology, engineering, and mathematics) classroom with the content and create a space for valuable participation (Pierson et al., 2021). Instructional materials in the learner's home language and translingual classroom practices improve their test performance, foster a comfortable learning environment, and bring awareness of their languages' rich scientific knowledge (Charamba, 2019). There are studies on translanguaging practices positively impacting students' academic achievements in science classrooms. However, the specific impact of translanguaging on the students' conceptual understanding in science classrooms is still underexplored. Further research on conceptual understanding and the role of translanguaging in fostering content knowledge is likely to promote better learning outcomes in science classrooms.

Based on the three directions of research on translanguaging in science and content classrooms in different multilingual global contexts presented above, the present study explores translanguaging practices and Indian teacher' perceptions of their use of the practices and the impact of using pedagogical translanguaging on science learning outcomes in Indian classrooms as a novel area of research.

6. METHODOLOGY

6.1 Research Approach and Questions

This study draws on data from an embedded case study investigating the practices and perceptions of five science teachers working in EMI secondary schools in Telangana, India. The research questions addressed in this study are:

- How do science teachers perceive their translanguaging practices in their classrooms?
- According to teachers, how do their practices shape students' conceptual clarity?

6.2 Tools Used

Semi-structured interviews of the five teacher participants were conducted to address the two research questions. Lu and So (2023) and Tai (2022) used semi-structured interviews to conduct teacher interviews in their studies to understand teachers' perceptions of their practices in their science and maths classrooms. Semi-structured interviews are used to gain in-depth information and insights from the participants on the subject of study. They are also helpful when the open-ended questions in the study require follow-up queries (Adams, 2015). The choice of the tool used is justified by the claim that it facilitates in-depth enquiry into practices, experiences, and perceptions of

the participants of the current study. In this study, ten interview questions were used. These were initially piloted with three teachers with the same criteria as required within the context of research, and later, the questions were specified and modified for use in the main study (refer to Appendix I for the questions). The interviews were a mix of formal, informal, and retrospective interview models conducted through voice calls, recorded and transcribed. The semi-structured interviews were a tool to collect qualitative data about science teachers' language practices in the classrooms and their perceptions on the impact on the students' conceptual understanding of scientific concepts that involved the following – (i) understanding the subject knowledge and scientific terminology, (ii) student engagement in argumentation skills, (iii) developing scientific enquiry knowledge through writing and (iv) active involvement with the multimodal resources in the classroom through teacher and peer interactions.

6.3 Context and Participants

Five teacher participants were selected using the convenient sampling strategy. The rationale for using this sampling strategy is that it is a non-probability sampling often used for qualitative research and is simpler, cost-effective, and quicker than other sampling strategies. It can be used to develop objectives and hypotheses if no other sampling strategies are feasible for the study. This sampling strategy is based on the participants' motivation to participate in the study (Stratton, 2021). This study involved five secondary school science teachers (Physics, Chemistry, and Biology) from EMI schools in Telangana, India. They taught 8th, 9th and 10th grades. Two female teachers were from private EMI schools, and three male teachers were from government-aided EMI schools. The teachers were proficient in Telugu and English. Table 2 provides the details of the five teacher participants. All ethical considerations were observed when selecting the teacher participants, and as per the agreement, pseudonyms are used to refer to them.

Table 2. Participant Profiles

| Name | Gender | Years of teaching experience | Educational Qualification |
|---------|--------|------------------------------|--|
| Manisha | Female | 4 | MSc Chemistry, B.Ed. |
| Aparna | Female | 13 | MSc Physics, MSc Biological Science, B.Ed. |
| Krishna | Male | 26 | MSc Tech Physics, Med, MSc Psychology, B.Ed. |

| | | | |
|----------|------|----|--------------------|
| Saikiran | Male | 25 | MSc Physics, B.Ed. |
| Vamshi | Male | 16 | MSc, B.Ed. |

6.4 Method of Data Analysis

The qualitative data was analyzed using a reflexive thematic analysis from the framework proposed by Braun and Clark in 2006 and later updated in 2021. It was based on an inductive approach with six steps to analyse data, which are as follows: first, the data gathered was categorized into the two main research questions. The responses concerning the teachers' perceptions of their language practices in the classroom were categorized under the first research question, and the rest of the data on the perceptions of impact on students' conceptual clarity was placed under the second research question. Second, the interview recordings were transcribed verbatim and were read many times for familiarization. The data was then coded using Taugette, a qualitative data analysis software. The inductive approach used to generate codes inherently facilitated the generation of themes from the data. Third, themes were developed in light of the research questions. Fourth, the themes were reviewed and revised to appropriate, omit inconsistencies, and ensure that they represented the participant responses appropriately. The themes and codes were then defined and named in alignment with the two research questions of the study, as included in Table 3 below. The last two stages involved drawing conclusions and reporting the findings. To maintain the rigour of thematic analysis, it was observed that the coding decisions are transparent. Reflexive journaling was utilized to acknowledge and reduce the researchers' bias during interpretation.

Table 3. Themes and Codes in the Teacher Perceptions of Language Practices and its Impact on Students' Conceptual Clarity

| Themes | Codes | Number of References |
|---|---|----------------------|
| Teacher perceptions of language choice | The use of other languages in the classroom | 7 |
| | Methods to incorporate the languages | 17 |
| | Reasons to use other languages in the classroom | 10 |
| Teacher perception of the impact on student learning (conceptual clarity) | Student participation | 3 |
| | Student language practices | 6 |
| | Conceptual clarity | 4 |

7. RESULTS

7.1 Teacher Perceptions of Language Practices in the Classroom

The study investigated secondary school science teachers' perceptions of translanguaging practices in their classrooms and their views of how it shaped the conceptual clarity of the students. All five teachers reported that they actively utilized activity/application-based strategies and megaphoning in their classrooms, along with translanguaging practices. Megaphoning involved explaining the concepts in the home language besides the MOI. The application-based strategy is similar to the translanguaging strategy of linguistic and cultural contextualization of the concepts and the activity-based strategies described by the teachers involved using multimodal resources to convey the concepts in their content-based subject classrooms.

All teachers used activity-based strategies, applied learning, and translanguaging in their classrooms. The teachers observed language practices as a critical aspect to support understanding of the subject knowledge and claimed that they use other language/s in the classroom to facilitate the following functions: (i) convey the concepts, (ii) compare and contrast with the terms in the target language to promote scientific language learning, (iii) give examples and synonyms of the complex terms, (iv) encourage participation in the classroom (example: to seek help from the teachers in their language, represent their ideas, ask questions and doubts), and (v) switch between languages to facilitate easy understanding of the scientific concepts. However, it is to be noted that these reports are perceptions of use and not practical classroom applications of translanguaging strategies, which is outside the scope of the current study. In the section below, instances of teacher perceptions about the role of the five purposes - (i) to (v) listed above - of translanguaging practices are reported.

Teachers reflected on their language practices and seemed to agree that language/s other than the MOI in science classrooms should be mediated according to the needs of the students and their level of current understanding.

Manisha perceives the use of the home language as beneficial to the learners. She shares: “I use English. If they do not know certain words, I tell them in Telugu. I can also tell in Hindi to students of Hindi language. If anyone is not understanding, for them, I sometimes use Telugu.” Krishna, from a government-aided secondary school, also used the home language of students and conveyed that he cannot use Hindi in science classrooms due to his lack of proficiency; he uses Hindi in his math classroom:

I will use English, but sometimes I also explain the concepts in Telugu. Hindi is not used much, as there are only a few students. I do not belong to the Hindi medium, which is why I cannot explain. If it is mathematics, if it is a problem, I can explain it in Hindi, but I cannot explain the physical science words.

All the five teachers reported that they used other language/s in their classroom language practices. Government-aided schools use bilingual textbooks in English and Telugu. The government teachers, Vamshi and Krishna, regularly taught in both English and Telugu languages simultaneously. Manisha and Aparna, who taught at private schools, used the students' home language/s based on their linguistic needs to understand a concept and claimed that using other language/s in their classrooms helped them convey the concept better. However, all five teachers, irrespective of their years of teaching experience, found language practice as a less challenging issue in their classroom. Using other languages in the classroom was mainly to build and facilitate an easy understanding of the subject and concepts and to get student feedback. Aparna claims: "The reason to incorporate other language/s in the classroom is for easy understanding and get a quick response from the students."

Manisha states that using their home language will pique their interest and participation in the classroom: "They will show more interest because it is their home language; they can talk more about their experiences and tell if they got the concept or not." Government-aided school teachers used the home language mainly to facilitate students' understanding of the subject and concepts. Vamshi explains the classroom language shift from their home language to English as the grades increase. He shares:

Teaching is first in English, and after that, we teach in Telugu, because until the 8th class, up to 6th and 7th, we practice Telugu to English, home language to English, to switch on the language. In the 8th class, it is English to Telugu. In the ninth, it is more English to English. If the students do not understand any concept, we explain it in their home language.

The language practices included using words from the learners' home language for complex terminologies and giving examples to facilitate understanding. Using a few words from the learners' home language to simplify complex terminologies and concepts was unique to the EMI teachers. However, the teachers were willing to explain the concepts in the student's language if they sought help. Aparna gives an example of the practices she implements in the classroom. She uses common terms for a better understanding of scientific terminology:

We use Hindi/Telugu terms just to make them understand easily and can relate to the examples which he/she knows or learned in his/her childhood; for example, some natural indicators, scientific names of plants or animals, and many more. Example: Turmeric indicator- Pasupu/Haldi, Hibiscus rosa Sinensis as Mandaram in Telugu.

Vamshi explains that bilingual textbooks play an essential role in addressing the terminology problem in his classroom:

In the bilingual textbooks, in the same pattern, we have English and Telugu beside each other. If the students have taken English medium directly here, if there is a terminology problem, it is useful. So, in classroom teaching, we teach in English, as well as in their home language, so that they understand it.

Krishna shared his languaging practices in his classroom for comparing and contrasting the texts from English and Telugu and for facilitating understanding of the concepts:

First of all, we need to read and explain in English, and after that, we need to explain in Telugu. I will explain in Telugu, those concepts and again, I will ask the question in English so they can understand it easily in their mother tongue. So, first of all, we teach one language and then go for the mother tongue. This is called megaphoning.” This is a pedagogical word, and it is very useful for children who are coming from other mediums.

Vamshi and Krishna practised explaining the concept once entirely in English and once in Telugu to convey it more clearly to suit their understanding levels. However, Saikiran perceived it less valuable to use one language for the entire concept and switch to another language and instead suggested switching between languages as per the needs of the learners:

The government has introduced bilingual textbooks. Megaphoning is nothing but the use of the home language and switching over to another language. It is definitely being done, but all the way, just in English or Telugu is bad. Generally, how best the children can better understand, according to the situation, we should switch.

Krishna shares his activity-based teaching strategy based on real-life application, which can be categorised as a multimodal resource. He claims they engage the students and make the concepts more relatable. He shares:

I would prefer to teach in activity-based learning. So, I will do so many activities. For example, the sound is produced with the vibrations. So, if you touch your throat while speaking, they can understand and organizing some sounds. I will call some boy and some people will call him and they need to identify the words, who called him, like that. So, activity base is very important. So, they have so much of enthusiasm to participate in those activities, and they will definitely learn something in those activities.

However, Manisha also raises concerns about the implementation of translanguaging strategies in her classroom. She claims:

In our school, Telugu is strictly not allowed except in Telugu period, and Hindi is allowed only in Hindi period. Except that, they should talk in English only. In case he/she is unable to talk, they can use one or two words of their own home language.

Based on the examples provided above, it can be concluded that all the teachers had positive perceptions of their translanguaging practices for teaching science.

7.2 Teacher Perceptions of the Impact of Translanguaging on Students’ Conceptual Clarity

All the five teachers allow their students to use their home language to understand the concepts and interact with each other. Krishna shared how students face difficulty when they shift from their home language medium schools to EMI and continue to use their

home language to understand the concepts: “It is difficult to understand the concepts coming from the Telugu medium background and converting to English medium. So, those students will interact in English, but most of the students will interact in Telugu itself.”

Manisha points out how the students might not participate in the classroom if their home language is omitted: “They might be scared to ask doubts in English, that they might commit mistakes. If it is their mother tongue, they ask.” Saikiran claims that it will be challenging to build conceptual understanding without using the learners' home language. He gives an example as follows:

Without using their mother tongue, the concept will not get injected into their brains. How can we explain them without using the home language? English is a foreign language; moreover, in rural areas, their parents may not be able to provide them with English communication; in that case, how will they understand?” For example, I am explaining ratio... ratio is two things in comparison; we use comparison but not use ‘Polchadam’ (Telugu). When such words appear, it is difficult for them to understand Telugu. The terms are mostly in English, but connecting words are in Telugu.

The teachers' perception of the impact of translanguaging practices' on the student's conceptual clarity was highly positive. Manisha shared that these practices serve various classroom functions, such as increasing the student's interest and understanding of the concepts and facilitating their participation in conveying messages and clarifying doubts. While explicating the use of other languages in her classroom, she describes:

If I speak in English, some students understand. If they have doubts, they can't speak in English; what they want to say, they can't tell. If you tell in Telugu, or if they are going to ask in Telugu, they can ask. If in English, it might be they can't ask clearly. If in Telugu, they ask. They might not know English. They might be scared to ask doubts in English, that they might commit mistakes. If it is their home language, they ask.

Vamshi reflects how the students gradually gain proficiency in the language used as the MOI and understand the concepts clearly:

Sure, there will be improvement. If it is entirely in English, they might not understand. If we use their MT and switch them on to English, there will definitely be an improvement. Even if they faced difficulty in the beginning, now they are habituated to it. They are trying to understand English. Even if they explain in their MT immediately, as we have bilingual textbooks, if we make them read the topics in English, they will learn both. In MT, they understand the concept easily, but we must express it in English; they will not have much difficulty.

Aparna shared that these practices can help understand the concepts, specifically for students who have difficulty representing their conceptual understanding of the concepts: “It can be advised for slow bloomers if they understand the concept in their home language, they can frame sentences and explain the concept.” Krishna perceives using multiple languages in the classroom as helpful in facilitating conceptual understanding among the learners. He explains a classroom practice and states.

The teachers need to read that text in English, and they need to explain it in English. After that, the children need to understand and identify those texts in Telugu. They need to compare. So, what is going on in English, and what is going in Telugu? Definitely, they will get some understanding of the concepts.

The teachers perceived that translanguaging would facilitate a gradual shift from using home language instruction to EMI and promote conceptual understanding of the subject knowledge among the learners in their science classrooms. This would not be at the cost of poor understanding in science or other content subjects as the transition from using home language resources to build conceptual clarity would then be transferred to the other language of instruction, English, which is a desirable goal of secondary and higher education in India and globally.

8. DISCUSSION

The findings presented here document five secondary school science teachers' accounts of their translanguaging practices and perceptions of the impact of their practices on developing students' conceptual clarity. Two teachers belonged to English medium secondary schools, and three teachers were from government-aided schools where dual language practices of Telugu and English are followed.

The findings suggest that just like the teachers of EFL, ESL, and EMI use translanguaging in their classrooms (Anderson, 2022; Anderson & Lightfoot, 2018; Mukhopadhyay, 2020; Lightfoot et al., 2023), the science teacher participants in this study also use translanguaging practices systematically in their classrooms and show a practical application of the pedagogical translanguaging model. The teachers adopted inclusive language practices, incorporating students' home languages to encourage participation. They use translanguaging practices for various functions ranging from conceptual clarity to students' active participation in class. All the teachers use other language/s other than the MOI in their classes to convey scientific concepts and theories. This finding is in line with the findings of Kääntä et al. (2018), Lu and So (2023), and Rahman and Singh (2022). Next, the teachers used words from other languages to simplify, translate or give examples of the complex terminologies of the subject in the students' home languages, as they perceived that it helped the students to understand them easily. This aligns with the findings of Charamba (2022), Infante and Licona (2018), Kääntä et al. (2018), Lu and So (2023), Pun and Tai (2021), Poza (2018) and Tai (2022). The above-mentioned studies identify that the practice of translating scientific and mathematical terms into the home language of the students helped them build scientific knowledge and encouraged participation in scientific discourses in the classroom.

Facilitating the understanding of scientific concepts emerged as a recurrent purpose of translanguaging in the teachers' languaging practices. The teachers heavily emphasized the aspect of 'understanding' the subject and concepts, which aligns with the claims of

Widiyatmoko and Shimizu (2018) that understanding is an integral part of basic competency in learning scientific concepts. All the teachers strongly believed that using the students' language/s should be a practice to build their understanding of the concepts. Infante and Licona (2018) similarly identify translanguaging as a linguistically sensitive approach to building a conceptual understanding of science education.

Another function that translanguaging serves in the classroom of these teachers is to encourage participation (for example, asking questions, clarifying doubts, and conveying their ideas) and promote their interest in the subject. Manisha firmly expressed that using the students' language/s in the classroom will encourage them to develop an interest in the subject and participate actively in the learning process. These findings align with the investigations of teacher perceptions by Charamba (2020b) and Pierson et al. (2021). Although there is research investigating science teachers' perceptions of translanguaging practices, there is a lack of research evidence in the Indian context about their uptake in teachers or their impact on science learning outcomes. This study extends on the previous research on science teachers translanguaging by adopting a case study approach of the translanguaging strategies of the five teachers and builds a repertoire of the strategies they implement in their classrooms to facilitate conceptual understanding through languaging practices besides exploring their perception of its impact and use in the classroom.

The teachers had a positive perception of the impact of translanguaging practices on the conceptual clarity of the students. As mentioned earlier, the teachers focused on building the students' conceptual understanding in the science classroom. They allowed the students to use their language/s in the classroom to communicate their ideas, ask questions or clarify doubts, and seek help from the teachers' when needed. Similarly, the teachers used the students' language/s to facilitate their understanding of the concepts. Vamshi and Krishna shared that the students shifting from home language instruction to EMI schools face difficulty understanding the concepts and need home language support. Vamshi further elaborates on how the bilingual textbooks in their curricula help the students understand the concepts and learn the language simultaneously. These findings align with the findings of Charamba (2020a, 2020b), Infante and Licona (2018), Kääntä et al. (2018), Lu and So (2023), and Rahman and Singh (2022). All the teachers, except Aparna, shared that the students can understand the concepts better when their home languages are used alongside English in teaching. According to Aparna, such a strategy should be mediated for the students who find it difficult to understand the concepts in the target language. Understanding is integral to the science classroom and the teachers' languaging practices. However, few studies investigate the relationship between translanguaging and building understanding in concept-based classrooms and the teachers' perceptions of these practices.

This study attempts to add to the literature on teacher translanguaging practices in science classrooms and investigate an underexplored issue in the Indian context; certain limitations are to be acknowledged:

1. The small size of five teacher participants makes it difficult to generalize the findings and apply them to a large number, leaving space for tentative generalizations at best.
2. As one researcher conducted the online interviews and data collection, there is a possibility that it must have given away subjectivity to impact the reliability.
3. The data collected is only through the semi-structured interviews conducted online; further research can collect data through classroom observations, survey questionnaires, and focus group discussions with the teachers and students to validate (a) actual practices in science classes in India and (b) impact of the translanguaging practices on student learning outcomes.
4. As this is a self-reported study, it is to be acknowledged that there exists a challenge of disconnect between participants' perceptions and practices in their classrooms, as the perceptions are not corroborated with any other form of empirical evidence.

9. CONCLUSION

The current study has mainly explored the perceptions of science teachers on their language practices in their classrooms and their perceptions of the impact of their practices on students' conceptual clarity in Indian classrooms. The study is a crucial first step in documenting teacher perceptions of their translanguaging practices for teaching concepts in science classrooms. Future studies should examine teachers' actual language practices in science and other content classrooms, in addition to ESL settings. The findings of this research study can be used to build a repertoire of the strategies implemented by the teachers that can serve as a toolkit for pre- and in-service teacher training. Policy makers can target teacher training programmes that emphasize on these strategies that will enable them to construct positive attitudes towards accommodative and non-hierarchical perceptions of (trans)languaging in language and concept-based subject classrooms, ensuring effective implementation in their classrooms. Additionally, curriculum designers can integrate these strategies, exclusively focusing on supporting and facilitating both conceptual understanding and language learning, aligning with the learning needs of the students in the science/math classrooms in multilingual contexts.

A significant function of science classrooms is facilitating 'understanding' of the concepts in the subject. However, Lemmi et al. (2021) state that science frequently becomes a context for facilitating literacy in under-resourced institutions. Teachers are pushed to focus on English and maths, emphasizing language production over conceptual understanding. Newton (2011) argues that understanding is an effort and time-consuming process that easily falls in the background. Further research can investigate how translanguaging practices are used or can be used to facilitate understanding in concept-based classrooms as well as build cognitive academic proficiency skills in a new language like English that is not readily available as the home language to the majority of Indian students. It is likely to contribute to effective teacher

practices, continuous professional development, and teacher education training programs for science teachers and other concept-based subject teachers. Investigating the student perceptions of teachers and self languaging practices and their impact on their conceptual clarity in concept-based classrooms can be taken up as a future direction of research to facilitate better learning outcomes.

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APPENDIX A

Interview Guide

1. Do you use any language(s) other than the designated language of instruction in your science classroom? If yes, please specify which language(s).
2. What are the reasons for you to incorporate other languages in the classroom?
3. How do you incorporate them into your science classroom?
4. Do you use specific strategies to switch between languages in the science classroom?
5. How do you believe utilizing other language(s) facilitates learning among the students in science classrooms?

6. How are student language practices in science classrooms/ are they allowed to use other languages to convey meaning, ask questions, and clarify doubts in the science classroom?
7. What is the difference in student participation when using multiple languages compared to using one language as the MOI?
8. What are the challenges of using other languages in a science classroom? How do you address them?
9. Did you receive training in language practices in science teacher education? Do you think teachers should receive training in language practices to enhance instruction in science classrooms?
10. Do you think utilizing other language(s) in the classroom aids conceptual clarity, and what is the impact on the students' learning outcomes?