

Science teachers' perceptions of the role of language in pedagogic practices in plurilinguistic EMI settings in India

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ABSTRACT

Supporting learners' understanding of science-specific concepts in English Medium of Instruction (EMI) contexts is challenging due to the multiplicity of registers and languages at play, yet a vital element for learners to progress. Understanding teachers' beliefs and experiences of using multiple registers and languages of the EMI science classroom is a crucial step towards achieving this goal. The present study was conducted during the Covid-19 pandemic across two continents (India and UK) via four three-hour activity- and reflection-oriented online professional development workshops with a set of science educators (n=20) involved with the English medium education school system (chiefly the primary and middle school levels) in India. The workshop was led and facilitated by two language specialists with English for Academic Purposes backgrounds. The aim of the study was to explore the science educators' beliefs about the role played by the multiple registers and languages used in their teaching environments when they teach subject-specific concepts. We used a sociocognitive framework to design the activities for the workshops and, through a thematic analysis of the recorded transcripts, explored the teachers' responses and beliefs as they evolved during the workshops. Despite the limitations of our findings, we found that the participants showed a strong awareness of the language challenges faced by their learners, especially at a word level. Their reflections on their practices indicate they were skilled meaning negotiators between different languages and keen on plurilingual approaches in their classroom. They had some understanding of the communicative purposes of registers, which further developed during the workshops. We were also able to explore the latent relationship between conceptual understanding and language use. For instance, some held on to the view that the language of textbooks is a neutral conduit of facts, while the concept of 'construal' challenged others' perspectives.

KEYWORDS: Language Awareness (LA), science teacher education, concept formation

INTRODUCTION

Most educationalists would agree that classroom environments characterised by knowledge creation are preferred to those in which knowledge is simply replicated. Such epistemically rich environments that support learners to actively generate and validate their ideas are built on teachers' understanding of the role the various languages of the classroom play in creating new knowledge (Fulmer et al., 2021). Language in all its varieties and forms can potentially enable both concept creation and concept representation and is the most fundamental epistemic catalyst teachers have to create rich learning environments (ibid). Yet, teachers' understanding of how to orchestrate these languages to build such epistemically rich, deep learning environments depends on teachers having a good degree of teacher Language Awareness (LA), defined as 'the knowledge that teachers have of the underlying systems of the language that enables them to teach effectively' (Andrews, 2007, p.ix). This applies to all content areas, including science.

The Indian school science teacher faces specific challenges of the plurilingual constitution of the classroom, where the medium of education can be a regional language or English. English Medium Instruction (EMI) also takes varied forms, depending on the school's funding body (state or private), and each state board's policy on what medium shall be adopted and at what grade. Despite this variation, a common concern that many EMI teachers in India have is the extent to which the students' understanding of the content suffers when the medium of instruction is different to their heritage language (Briggs et al., 2018). With the intricacies of teaching in a plurilingual, postcolonial context, such as India, it is therefore crucial that EMI teachers have confidence in supporting their learners' knowledge generation practices whilst drawing on all the various languages and semiotic resources available to them.

Current models of Language Awareness (LA) for EMI teachers, such as the one proposed by Xu and Zhang (2022), emphasise the importance of content teachers being language-aware and language teaching-aware. This not only involves knowing what roles the learners' heritage language(s) and English play in the knowledge building processes in their context, but also recognising the discourses of postcolonialism that enable certain power hierarchies to sustain between the various languages in play. Furthermore, as each disciplinary register has its own language patterns and communicative purposes, teachers benefit from an awareness of the variations among different registers found in the science classroom and the social situatedness these registers are aligned with (Schleppergrell, 2004; Rose, 2006; Daborn et al., 2020).

To our knowledge little attention, however, has been given to the cognitive dimensions of the knowledge generation process by EMI specialists. That is, the role of *language*, not only for communicating meanings, but also as a constitutive element of the concept formation process, is often overlooked. We argue that successful knowledge generation in EMI settings rests on teachers not only understanding how to develop learners' ability to communicate meanings, but also understanding the cognitive meaning-making processes involved, through the navigation and manipulation of the classroom's multimodal and multilingual semiotic networks. Referred to as 'symbolic competence' (Kramsch, 2006, p.251), this involves the ability to understand how learners might interpret (multiple) meanings of concepts from discourse features of different languages and registers in the classroom, by appreciating how word choice and different linguistic forms can affect conceptual understanding.

With these concerns in mind, we set out to conduct a series of online professional development workshops conducted via Zoom during the Covid-19 pandemic to explore 20 Indian EMI science educators' (school teachers and teacher trainers) understanding of how language is a fundamental epistemic catalyst, thus providing them with the means of moving beyond simply viewing language as a 'labelling system' (Sutton, 1992, p.53) and a vehicle for transferring or replicating information, to one which highlights its meaning-making potential. In effect, the workshops carried dual aims: a. through various task-based exercises and discussions, to provide these science educators with the means to explore and critique the various semiotic modes available to them to bring about an eventual epistemic transformation in their own local contexts; b. through the generated discussion and output, to provide the facilitators qualitative data on the Indian EMI science educators' beliefs about the role of language(s) in their pedagogic practices.

Based on the concerns of the Language Awareness model that places the meaning-making process at its heart, and keeping in sight the Indian context, these are the key research questions that drove the workshop and our investigation:

1. What are the beliefs of school level science teachers in India about language use of various registers that inform their pedagogy?
2. How do school level science teachers in India reflect on the role of language when teaching subject-specific concepts?

3. Underlying the above two questions is the larger context of multilingualism: how do school level science teachers in India incorporate the inherent multilingual resources of the classroom when teaching subject-specific concepts?

India's Language and Pedagogy: A Brief Context

It is important to locate the sociocultural and linguistic specificities of this workshop's participants and facilitators. Since the participants were all from India, the Indian linguistic context became a key factor for the research questions, designing activities, and eliciting responses. Given the large number of languages used across the country (Mohanty, 2006), the school-level education system broadly follows a three-language formula (Hindi, English, and a modern Indian language) (Pattanayak, 2003). More recent government policy formulations like the National Education Policy (NEP) 2020 have stated no particular language is mandatory in the education set-up, and there are increasing efforts to integrate the advantages of bi- and tri-lingualism in school education (Morve and Maurya, 2022). The application of these policies on the ground, however, is very varied.

Based on funding sources and governance bodies, Indian schools are broadly divided into three types: government funded public schools, privately funded but government subsidized schools, and privately funded and privately run schools (Mousumi and Kusakabe, 2022). Schools, public or private, may teach English as a subject or use it as a medium of education. Most public schools use the dominant regional language as the medium of education (Tickoo 1991, 1996). The lure of private schools is that most are (or claim to be) English medium schools (Mousumi and Kusakabe, 2022). Although English is not the L1 or even L2 for most people in India, especially those from rural or tribal backgrounds whose exposure to English is nil even through social channels, the cultural aspiration for EMI education is widespread. So, when there is a move from a regional medium to an EMI school at a higher grade, or when children from regional medium backgrounds apply to national colleges, the learners invariably suffer due to linguistic gaps and face both learning difficulties as well as social ostracization from those for whom English is accessible socially and academically (Morve and Maurya, 2022). Children in non-EMI contexts may often not even use the standard dialect or regionally dominant language of the state. Education policies and pedagogic practices, therefore, need to focus deeply on not only what language is the medium of education in a particular geographical region but also on harnessing the inherent plurilingual nature of (Indian) classrooms.

Theoretical underpinnings of the workshops

Despite the complexity of teaching in a language that is different from the students' and often teachers' heritage language, EMI practitioners rarely receive guidance on how to overcome the language challenges they encounter in the classroom (Xu & Zhang, 2022). Yet, as previously mentioned, the effectiveness of EMI as a pedagogical approach depends on teachers being language-aware and language-teaching aware. Efforts amongst EMI teacher-educators to address this need have perhaps understandably focused on teachers' awareness of the strategies used to develop their students' language skills such as speaking and writing in English, and more recently their understanding of the role their students' L1 plays in the learning process (Lu et al., 2023). However, teaching any subject also requires an awareness of the subject's specific language patterns and features. Whilst often not a focus of teacher educator programmes, there is amongst EMI specialist the recognition of the crucial importance of developing disciplinary literacy awareness amongst content teachers working in EMI settings at all levels of education (Krulatz, 2020). An influential theoretical approach taken by teacher educators on such programmes is Halliday's systemic functional linguistics (SFL) that places and emphasis on the correspondence between the communicative goal and the language structures selected.

If used by EMI science educators, SFL can help learners develop a critical awareness of how subject knowledge is co-constructed across the different registers of that subject (Seah et al., 2011; Avalos et al., 2017). Unlike traditional approaches to grammar and lexis, SFL pairs for each linguistic unit the form and function that reflects the communicative purpose of the unit (Halliday, 2007).

Understanding meaning making in science as a social practice this way has provided teachers with the necessary concepts and metalanguage to highlight and explain lexico-grammatical variation across registers, including scientific writing, traditional textbooks and new media registers.¹ It also provides them with a greater awareness of the social situatedness of the language of science.

Less prevalent in current EMI pedagogy but increasingly recognised as an enabling framework for content teachers to be able to support their learners' access to their subject's abstract concepts is cognitive linguistics (CL) (Deignan et al., 2022). Closely aligned with SFL, cognitive linguistics (CL), emphasises the importance of linguistic 'motivation'. Instead of treating language patterns and choices as arbitrary, CL treats language use as reflective of more general cognitive processes, which

¹ Widdowson (1979) provides a model of three broad register variations within science: science as a discipline, found in journal papers, which assumes largely shared knowledge and modes of expressions, and is meant for communication between specialists in the field; science as a subject, which is a discourse between teachers and students, exemplified in textbooks, whose didactic and explicit rhetoric derives from and shapes pedagogic methods; and science as a topic of interest, between a journalist and the lay reader, found in newspapers and magazines.

are related to our embodied meaning making capacities and are mediated through culture (Littlemore, 2009). Cognitive linguists look at language use in the real world to find plausible explanations for different meanings of grammatical patterns and polysemous words that are often related through metaphorical extension. Applying this principle to the classroom can heighten learners' understanding of the key concepts (Sutton, 1992; Brown, 2003). For example, by explicitly exploring the effectiveness of certain analogies and frequently used metaphors together, e.g., a greenhouse for understanding the greenhouse effect or pump to understand the heart, can help learners develop a deeper understanding of the concept and the reasons why we use certain words to describe and explain it.

Being a usage-based approach to language, language development in an EMI setting from a cognitive linguistic perspective can be understood to be a situated practice, involving general cognitive processes in which a strict separation between languages, (e.g., English and the learners' L1) and modes may be unhelpful. Instead, it acknowledges that meaning-making that typically takes place in an EMI classroom is fundamentally a multimodal enterprise involving a full range of semiotic resources (Fröhlich, 2019) that draws on the experiential knowledge of the learner (Kolb, 1984). This holistic view of the learner acknowledges all the meaning-making resources learners bring to the classroom, including their cultural and multilingual schemas. This view opens a more fluid approach to language practice in plurilingual classrooms than immersion settings that uphold a strict separation of the learners' heritage language and the target language. Proponents of this cognitive view maintain language work involves not only translating between the two languages by code-switching whereby the form-meaning relationship is disclosed, but also by 'multilingual elaboration' (Boers, 2021) or 'grammatical translanguaging' (Llopis-Garcia, 2019) through which learners actively look for associations and patterns across the languages they use to build knowledge. Drawing on these principles, participants were actively encouraged to draw on all their linguistic resources, to make sense and share their insights mirroring the multilingual pedagogical practices that they could then enact in their own teaching. During the workshop themselves, multiple languages were in use during the discussions; the participants also reflected on their classroom practices of using several languages (discussed below). They also talked about accommodating students' inability to write lengthy answers in English during class tests by offering alternate ways of answering questions such as through diagrams (discussed below).

METHODOLOGY

Participants, Investigators, and the Workshop Set-Up

There were 20 participants in this workshop, a mix of mid-career middle and high school science teachers from English medium schools in India, one early-career English teacher who also works as a substitute science teacher at the primary level, a freelance adult educator, one science educationist who is also a middle-school teacher, one graduate researcher, and four full-time science teacher trainers. At least three Indian language groups were represented, but communication in the workshop sessions was primarily in English. The participants were selected on the basis of an application form, which included a short essay-type response on what role language plays in their classrooms. The entire workshop was conducted online (over Zoom), and was recorded with the participants' explicit consent after receiving ethical approval from the researchers' respective institutions. The digital recordings were fully transcribed by the researchers. To ground our interpretations, we returned regularly to the original recordings and used the research questions posed to ourselves at the beginning of the workshop to interpret the transcripts, first independently and then together to discuss emerging themes and also to enhance inter-coder agreement or 'interpretive convergence' (Saldaña, 2009, p.27).

We (the two researchers), come from different cultural backgrounds but have a common background of English for Academic Purposes. We wanted to avoid a top-down prescriptive approach; hence, the sessions were designed as dialogic spaces around a text or topic, and were reflective in nature rather than theory-heavy. We called ourselves facilitators during the workshop, and envisioned our role as encouraging discussion around selected topics, and introducing key concepts and enabling meta-language at vital interventional moments. We viewed our methodology as transformative pedagogy, one which is mediated by its participants, concepts, social interactions as well as texts and artefacts (Johnson and Golombek, 2020). Such an approach of collaboration and constructive dialogue has great benefits for both researchers and teachers so that research and practice may inform each other rather than be at cross-purposes, given that the aim of both is improvement in student learning (Sato and Loewen, 2022).

The analysis broadly takes an ethnographic approach in order to understand the 'worldview of the participants' (Cohen et al., 2017, p.292), i.e., to explore the participants' views and beliefs about the role language plays in the knowledge construction process in their own teaching contexts and to observe how these views developed throughout the sessions. During the four online workshop sessions, some of the exercises and texts presented for discussions were on topics taught in Indian

schools (e.g., infectious diseases and electricity), but there was also a lateral focus throughout the workshop on Covid-19 because of its experiential immediacy, sociocultural relevance, and pedagogic potential.

FINDINGS

Understandings and beliefs about (classroom) registers

The SFL concept of register was familiar to most of the participants (evidenced through their ability to identify various registers), though they may not have consciously dwelt on it within the bounds of the classroom practices, especially from a sociolinguistic perspective. We (the researchers) began with the assumption that the various registers associated with the classroom (see Figure 1) are in a relationship of dynamic interplay, in that the boundaries between them are often blurred.

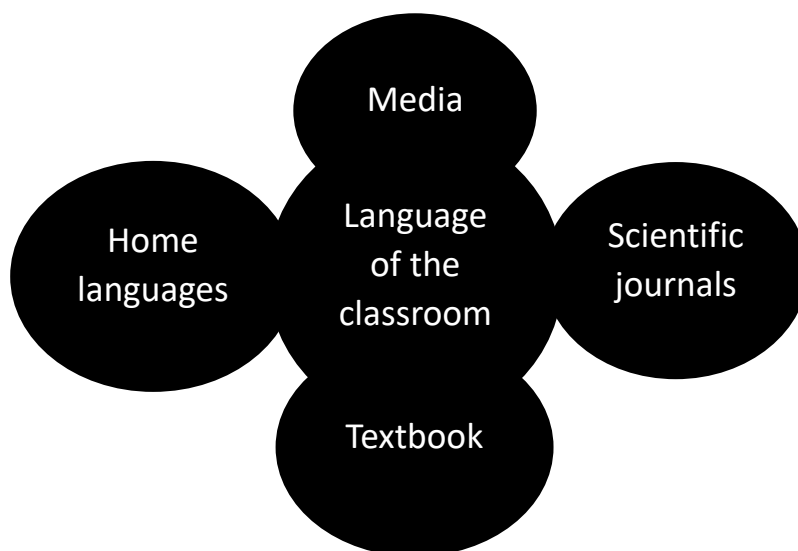


Figure 1: Registers relevant to the science classroom

To understand the participants' beliefs about registers, they were presented with extracts from different sources their learners and they (as teachers) may encounter inside and outside the classroom. These included media reports, multimodal health campaigns, and textbook chapters on infection. They were asked to identify each register and justify their answers by exploring the extracts' lexico-grammatical features. The aim was to develop a critical awareness of how scientific language varies across a range of contexts according to their communicative purposes. One participant PD, commented on the communicative purpose and linguistic features of home language thus: 'home language we use for communicating between family members...[with] family members, family friends. More of local words, local language words are used than technical words'. An

immediate difference noted by PD and some other participants between home language and the language of scientific journals was the use of 'technical words'. Participants' reasoning suggests an awareness that the variation in language features, especially at a word level, from the desire to communicate effectively to the intended audience.

Ample literature suggests that teachers heavily rely on textbooks as sound sources of information, and treat entire bodies of knowledge as cohesive and neat encapsulations (Agnihotri, 2010). The language of textbooks is commonly imagined as a neutral conduit for fact-heavy knowledge, unmediated by sociocultural factors. Therefore, in this workshop, we paid special attention to collaboratively and critically analysing samples from science textbooks. Given that science textbooks, in particular, tend to represent science as a set of facts to be learned could be one reason that learners tend to believe science is 'encyclopaedic and immutable' (Lyons, 2006, p.597). The primacy of textbooks influences the choice of strategies teachers use in their teaching (Andersson-Bakken et al., 2020). This makes textbooks a vital register for critical enquiry. PN contrasted textbooks with scientific journal writing by commenting on its 'easy to understand' style:

Actually textbook language is concept based. It is easy to understand comparatively to research papers than mostly it is specific and application-based words are always utilized in textbooks, who is involved: students, researchers, scientists, and the language features are some words will be there, some technical words will be there, but the language will be suitable for these students.

The explanatory power of textbooks as well as its accessibility was rated quite high by all the responders, especially when compared to the language found in scientific journals. Many reported that they use their textbooks as a key source of ideal language as well in the classroom. At the start of the discussion, PY said the language of a particular textbook extract was telling us how '*it* [disease] *is*', a set of neutral, permanent facts:

I think, because here it's mostly just stated that what exactly happens. This is just what happens and it's a description of any disease as such, right from the infection period and the latent period and the symptoms so here, it is clearly telling you totally neutralised, in a neutral condition that how it is, it is not indicating regarding any other person as such.

PY uses the expressions 'just what happens' and 'telling you totally neutralised' to describe the purpose of textbooks, which supports Lyons's (2006) observation that much science in textbooks is presented to learners as a decontextualised set of facts. However, with some further close reading of the language of the extract, and by focusing on the features of this particular register, the participants were able to question the high explanatory value of textbooks as they had initially argued. PD pointed out that textbooks are likely easier for teachers than for students:

the teachers it is easier because they are teaching again and again and in the same class if they are teaching it becomes simpler for them, familiar, but for the students, it is not the case because at all repeated...but still for the first time when they hear the words and try to underline the text in that textbook and find out the answer...It becomes more like fact delivering machine than...understanding the content.

This observation that textbooks can act as a 'fact delivering machine' points to how conscious reflection on a traditionally accepted source of knowledge may lead teachers to question their unquestioning reliance on it. In this case, the participant is also pointing out the mediating role of the teacher between the student and the textbook, and how the textbook is not equally accessible to everyone. Our aim was to show that like all other sources of knowledge, the textbook is really a 'mediating tool,' a cultural artefact that has been developed to 'shape people's understanding of and interaction with the objects around them' (Andersson-Bakken et al., 2020, p.1321). By eliciting this particular response, we were able to show that the dependency on textbooks can be questioned through an analysis of its language.

Focusing on the language patterns found in textbooks this way drew on the core cognitive linguistic concept of 'construal' (Langacker, 2008). This concept acknowledges that we witness objects around us from a human perspective. The fact that we choose words to express a phenomenon implies there is no purely objective view of it. Drawing the participants' attention to this appeared to heighten PX's critical awareness towards the seemingly neutral language of textbooks. This was evident in later conversations, when PX noted:

Even the...direction, which we have of fertilization, and in textbooks, you know that it's the sperm chasing the egg, the egg is waiting and you know all these things if you... it it's not it's not neutral, there are unconscious biases there.

By reflecting on such construals, the teachers were able to challenge certain assumptions they held about the creation of some scientific concepts through their encoding in language. Such conceptual formations may be shaped by and reflect gendered and other biases (as in the case of the personification 'chase'), which such critical examination can further expose.

Beliefs about concept formation and meaning-making processes

Another key concept for meaning-making is through metaphors (and other figurative tropes) in pedagogic and scientific discourse. Due to its ubiquity in language (Lakoff and Johnson, 1980; Kövecses, 2002) and wide use as a device to explain difficult abstract concepts in pedagogical settings (Cameron, 2003, Low et al., 2008; Brown et al., 2016), we provided the participants with some explicit explanation of the structure and functions of metaphor, including personification, simile, and analogy through examples the participants were expected to have come across in their professional spaces. By making figurative language usage explicit, we aimed to demonstrate that even seemingly non-figurative genres like textbooks rely heavily (and inevitably) on figurative language use. We discussed the relative merits and limitations of some of these metaphors. PZ commented on some standard analogies that science teachers frequently resort to when explaining key concepts:

I'd say a heart as a pump is a better analogy than the water rope analogy for electricity. It doesn't explain voltage very well there's so many things about the comparison that are not good for that, it could actually lead to misunderstandings.

This example demonstrates a developing awareness of the limitations of such commonplace metaphors in science classrooms. As many of the participants found it hard to unpack why certain analogies and metaphors are more or less effective, we invited participants to offer metaphors for their then-new experiences of the Covid-19 pandemic. The participants felt that the more effective metaphors were those that compared the pandemic to a natural phenomenon, such as a volcano, a tsunami, or a fast-spreading fire, since each of these metaphors signalled to the user the imagination of the pandemic as natural and unstoppable. PB noted that many in Asia had in fact 'personally witnessed a tsunami' and had 'seen the devastation,' which made a natural calamity a particularly effective metaphor. PN noted that the pandemic was like a 'train without any brakes on', which evokes images of death and destruction at a very high speed. Such metaphors triggered past experiences of the participants, reinforcing the point that lexical items and concepts closely related to the learners' experiential knowledge may provide a more powerful starting point on which new

knowledge can be built. Others suggested 'waves', 'nightmare', and a 'pause button', each of which lent something different to the interpretation of the pandemic.

Participants were also encouraged to pay attention to the frequency of personification in science textbooks, especially apparent in verbs, for example, 'antibiotics are used to *fight* disease' (Roberts, 1986) frequently found in definitions and explanations that, according to Krennmayr (2017) translate the subject matter into a familiar experience. Towards the end of this activity, some participants appeared to become more confident in recognising figurative language and more explicitly aware of their potential use to teach abstract concepts. PN was receptive to this idea in particular, and the discussion prompted her to detect the use of metaphor and personification in her chemistry teaching: 'Very often atoms or molecules and different elements like to do something so it's very personification, they do things like share electrons, gain electrons, give away electrons'.

At the same time, they were also expressing the high possibility of misconceptions to become solidified when an inappropriate metaphor or analogy was used (see above example by PZ). On similar lines, the cultural appropriateness and effectiveness of metaphor was also discussed. For instance, PA commented on the use of metaphors like 'blueprint' in an extract from the World Health Organisation website on vaccines.² She evaluated this metaphor and suggested that it would be impossible for her grade 8 students to make sense of what a blueprint meant, and thus, it was an ineffective metaphor (and text) for them 'usually we don't make use of such words in science so this is something really difficult for students to understand'.

Using the multilingual resources of the classroom

Closely linked to cultural appropriateness is cultural alienation, especially relevant in the Indian context where, as outlined above, EMI in most cases does not overlap with the language(s) students use outside the classroom. For an activity that took place early in the workshops, one of the researchers read out a passage on photosynthesis in German, once without any supportive aids, and a second time (still in German) with a labelled diagram. The aim was to explore what feelings may arise in students when they encounter concepts in an unfamiliar language, and how they may make sense of them. After each reading, the participants were asked to reflect on how they felt. Most responses were affective, veering towards anxiety and confusion. The Padlet-recorded responses of some of the participants is given in the image below:

² The extract she used is: 'Vaccines contain tiny fragments of the disease-causing organism or the blueprints for making the tiny fragments....'.

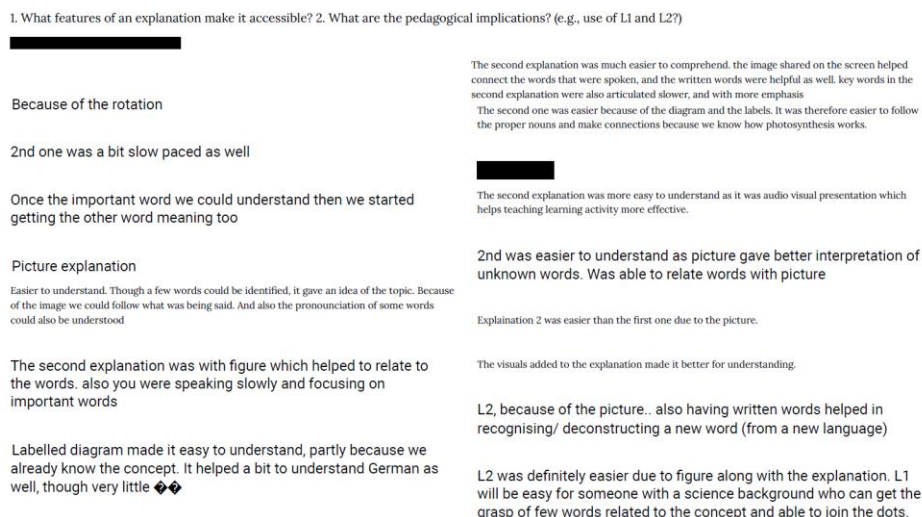


Figure 2: Meaning-making using multimodal resources³

Participants reflected on their own experience of this activity and discussed how unfamiliarity with the target language can cause distress to learners, both in terms of grasping a concept and in assessment of learning. They also commented on the helpfulness of diagrams for comprehension, and PN, using the process of ‘multilingual elaboration’ (Boers, 2021), elucidated: ‘I drew on my knowledge of the English words glucose and photosynthesis to help me understand the German’. These terms share lexical cognates with the English equivalent terms. In other words, students make use of conceptual knowledge from other languages and from their real-world experiences in the science classroom, and teachers need to be cognizant of this. This also implies that when the concept and the language of instruction are both unfamiliar, there will be much greater difficulty in the process of learning.

Several participants displayed awareness (and worry) about the difficulties of those students who are not comfortable with English in grasping scientific terminology and abstract concepts in an EMI setting. For instance, PV wondered what language was best to teach science in: English or the student’s L1. Her opinion was that ‘language should be known to the child, or at times, most used by the child’. Otherwise, it may lead to ‘reading but not understanding’. For most participants, multilingual strategies or on-the-spot translations among two or three languages were common because their students are from different linguistic backgrounds. So, while the school may mandate teaching in only one language (often English), the participants stated that they use a mix of languages to explain concepts. PS commented on being a constant translator when teaching:

³ Some participants misunderstood the symbolism of L1 and L2 in the question. In the responses recorded on Padlet, L1 refers to the first reading in German and L2 to the second reading in German coupled with a labelled diagram.

And I used to keep an English chemistry book, and a Kannada chemistry book, and as you see that in science and there's a lot of common language right and they [the learners] make sense of all the formulas and everything I'm teaching and, and I asked the students to tell them in Kannada, what it means, decode back in English, and then I used to explain it to them.

She further elaborated on translations *within* a language, emphasizing how registers play a role in communication:

So in the English language we translate between scientific language and lay language lay language and home language, so all these various languages and the translations that we carry out.

This reflection on not only multiple languages in use but also multiple registers in use was an important outcome of the discussions.

To aid students, PA pointed out that she allows for pictorial rather than verbal responses in middle-school exams so students can explain their conceptual understanding while bypassing English:

Yes, there are few students who faced problem in writing answers, especially when there is use of scientific words. So [in] the exams, I allow them to write pictorial answers. So if not words, they're allowed to express their answers in form of pictures.

Turkan & Lui (2012) have pointed out that when students do not have facility in a language, they are often unable to demonstrate their knowledge. Hence, assessment practices have to be cognizant of students' limited facilities with a certain language and offer alternative resources which the student can draw upon. Specialized subject-specific language in science education is challenging for all students and more so for second language learners (Karlsson et al., 2019). In a multilingual society, additive bi- or tri-lingualism, may offer resources that can be used to facilitate the transition from home to school and ultimately foster greater language awareness and learning empowerment. The other side of the issue that arises with EMI in a multilingual society is the loss of students' ability to use their home languages in the classroom. This is a challenge among urban schools, with their preponderance of English, sometimes at the expense of reading and writing abilities in the L1. PS pointed out this hierarchy in languages and the desirability of English at the expense of expertise in

other languages. She explained how her school's policy is to try and include other languages not simply in informal but also in classroom settings:

we try to take one particular topic every year... and make sure they are taught in the Hindi and the local language, so that the students and the parents are also forced that the kids should learn the language, so that that particular topic say for example water is going to be taught only in Hindi, only in Kannada, which means that the parents also will show some importance for the native language.

It is well-recognized in research that in a multilingual context, a sustainable system is one where different languages are deployed for different purposes within the school's pedagogy, the learner's strongest language is used to provide effective literacy, and languages are put to cooperative use so that educational and social tasks are shared. How these may be implemented in the actual Indian EMI classroom in a formal sense is still nebulous, but the move towards plurilinguality is certainly desirable. Here, plurilinguality is intended to mean an awareness of how different languages and their cultural inputs may contribute differently to knowledge creation in the classroom leading to richer epistemologies; it also points to being conscious of the linguistic context of the EMI school in India, where students (and teachers) may find their greatest ease of learning in different languages other than the target language. Studies on multilingual classrooms state that optimal learning takes place through various semiotic systems put into use simultaneously; a heightened awareness of the interplay of these systems, registers, and broadly language itself, will be grounds for enhanced pedagogic practices. PT also highlighted the interactive nature of the exchange between herself and her learners, demonstrating a co-constructive approach in her teaching. She chose the metaphor 'decode' to describe the process of going back and forth between the languages to unlock meaning and process information. Other participants used different metaphors to describe their translation practices: PY used 'bridges' (hinting at social mediation): 'then you've got to find bridges' and PB used 'untangle' (creating simpler links or highlighting pre-existing connections between concepts and meanings):

But the scientific meaning is slightly different but often it's based on something in the, in the home language, but it's I think our job as teachers to untangle that and try and help them with that transition.

Such metaphors (decode, bridges and untangle) reflect a complex reality of what science teachers experience when operating within a hybrid space between their everyday articulation of the world and a more conceptually driven one, as well as when various languages and registers are available to them and their students.

DISCUSSION AND CONCLUSIONS

Our project set out to explore how our participants perceived the role of language in plurilingual EMI science classrooms in India. We looked at the extent to which they saw the various languages and registers operating in the classroom as a basis of classroom members' conceptual architectures and concept formation processes. We further explored the perceived relationship between misconceptions and language, and therefore, how, by together examining these misconceptions through a socio-cognitive linguistic lens, we can better understand the ways we use language as educators.

Our findings showed that although our participants had at the start of the workshops some awareness of the different registers, especially at a word level, and their communicative functions, they tended to view science textbooks as a source of neutral facts. By comparing extracts from textbooks alongside other registers of the classroom, and by introducing the cognitive concept of construal some participants, they began to acknowledge the mediatory role of the textbook in the concept formation process and the power these texts have in shaping students' (mis)conceptions, whilst not relinquishing their reliance on textbooks.

By introducing some theory on metaphor in educational contexts into the dialogic space of the workshops and by drawing the participants' attention to the use of metaphors and other figurative tropes in pedagogical materials offered by the participants, the power of metaphor as a cognitive and cultural heuristic device in the concept formation process became increasingly apparent to some of the participants. This was evidenced through the pertinence of the examples they provided and their critical reflection on the effectiveness of the metaphors as a tool for conceptual understanding amongst their students.

Our findings also revealed that our participants, being mainly experienced practitioners, were strongly aware that the meaning-making processes taking place in their plurilingual science classrooms involved drawing on a full range of linguistic and multimodal repertoires their learners had. This affords an approach to thinking about language as a means to negotiate meaning, or as 'an

interpretative system' (Sutton, 1992, p.53) and one that may lead to epistemically rich spaces in which knowledge is created and not merely replicated. By reflecting on their meaning-making practices in their plurilingual contexts, the participants were able to acknowledge and reaffirm their own roles as negotiators in this dynamic knowledge building process. Despite English being the ultimate target language in their EMI classrooms and formal assessment practices, the participants expressed the need for classrooms to embrace the full range of available linguistic and multimodal practices.

Our adopted framework, derived from cognitive linguistics, sociolinguistics, and teacher Language Awareness, informed our fundamental assumptions about the role of language in conceptual knowledge, and the importance of the awareness of language use and its features. We avoided an overly prescriptive top-down approach of instructing how to achieve this, and designed the workshops to provide a collaborative, cooperative, and reflective space, so that the participants may express their developing awareness of the critical role of language in their classrooms. Through the use of certain key features of language like registers, metaphor, and contexts of multimodal and multilingual classrooms, we attempted to foreground the role language plays in all pedagogic activities. Finally, although it would have been interesting to explore how the approach translates into classroom practice, this lay beyond the scope of the study. Instead, we focused on working the participant teachers to collaboratively and critically analyse commonly used sources of knowledge and pedagogy like textbooks. Our assumption is that the more aware and reflective the teachers are of the way language shapes concepts, the more creative and effective they will become as teachers. The study had some limitations as well. Due to the pandemic and lockdown, the workshop sessions were held online, and because of screen fatigue and technological limitations, could not go beyond a few hours on the four days. As with all online participation, the participants were sometimes hesitant to speak up or put their ideas in chat, and the peer bonding and spontaneous (and charged) conversations that usually take place in in-person workshops were missing to some degree here. For this reason, it was difficult to capture the full extent of participants' views, especially those less familiar with digital spaces.

We hope to expand this project in the future by bringing in teachers from varied backgrounds, including state and private schools, urban and rural schools, and help them collaboratively reflect on their understanding of language and conceptual knowledge, and discuss the strategies and materials they use (or would like to create) to support learners' accessing content through the various

linguistic and cultural resources available to them, which would ultimately lead to a more involved, critical, creative, and reflective stance towards pedagogic practices.

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Acknowledgements: The authors acknowledge the help and support of Dr Neeraja Dashaputre (IISER Pune), Ms Shanti Pise (IISER Pune), Dr Asim Auti (IISER Pune), Dr Apurva Barve (formerly at IISER Pune), Ms Maryam Shaikh (IISER Pune), and Professor Srabani Maitra (University of Glasgow) for their various contributions to making the workshops possible. The researchers are also grateful for the MoU between IISER Pune, India and the University of Glasgow, UK for enabling this collaboration.

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