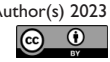
Article

LANGUAGE
TEACHING
RESEARCH

Language Teaching Research
1–33



DOI: 10.1177/13621688231152858
journals.sagepub.com/home/ltr


Embodied enactment of a hypothetical scenario in an English medium instruction secondary mathematics classroom: A translanguaging approach

Kevin W. H. Tai
Academic Unit of Teacher Education and Learning Leadership, Faculty of Education, The University of Hong Kong, Hong Kong

Li Wei
IOE, UCL's Faculty of Education and Society, University College London, UK

Abstract

Adopting a language other than the first as the medium of instruction in teaching mathematics can create significant problems for students' mathematical learning. However, there is little research on the ways in which bi/multilingual mathematics teachers can make use of diverse multilingual and multimodal resources to keep students engaged in learning abstract mathematical knowledge. This article aims to explore how an English-medium-instruction (EMI) mathematics teacher creates different hypothetical scenarios through embodied enactments to enhance students' mathematical understanding and motivate students' interest in learning mathematics. The data of this study is obtained from a focused classroom observation in a Hong Kong EMI secondary mathematics classroom. Multimodal conversation analysis is employed to analyse the classroom interaction data, and the analysis is triangulated with video-stimulated-recall interviews which are analysed with interpretative phenomenological analysis. This article aims to extend the notion of embodied enactment as a form of translanguaging to facilitate mathematical learning and develop students' motivation in learning mathematics in the EMI setting. Particularly, this article argues that embodied enactment creates a translanguaging space for the EMI teacher to achieve mathematical teaching.

Corresponding author:
Kevin W. H. Tai, Academic Unit of Teacher Education and Learning Leadership, Faculty of Education, The University of Hong Kong, Hong Kong
Email: kevin.tai@hku.hk

Keywords
embodied enactment, English medium instruction, Hong Kong, mathematics, translanguaging

I Introduction

Learning mathematics through a second language (L2) presents additional and unique challenges. A perpetual concern has been how mathematics teachers can facilitate classroom discussion in and through an L2, particularly when the students are still developing their L2 mathematical literacies and their L2 English proficiency and are concurrently learning abstract and unfamiliar mathematical knowledge (Robertson and Graven, 2020; Tai, 2022a). Motivation and engagement are important. So is gaining understanding through the L2. Do multilingual learners know the mathematical concept, fact, method, or reasoning already in their first languages (L1s)? If yes, can we make good use of the knowledge they already have in their L1s in learning through the English medium? Another concern raised by scholars is about how mathematics teachers can use different resources to bridge the differences between the students' everyday life culture and the cultures of school mathematics (e.g. Bozbiyik and Morton, 2022; Tai & Li, 2020; Teo, 2008). Bridging such a gap will assist teachers to make the mathematical knowledge more relatable and relevant to the student's everyday life experiences (Hand, 2012; Tai & Li, 2020). The present study aims to show how a bilingual teacher in an English-medium-instruction (EMI) mathematics class in a secondary school in Hong Kong (HK) draws on diverse linguistic and multimodal resources to construct different hypothetical scenarios which, in turn, allows the teacher to facilitate students' learning of mathematical knowledge and promote students' interest in learning mathematics.

EMI refers to the teaching and learning of content subjects through English as an L2 (Macaro, 2018). EMI is still maintained in post-colonial regions, such as HK where the present study is based, and is increasingly popular in emerging economies where access to English is deemed to be an important step towards globalization and internationalization (Lo, 2014). Recent research on EMI classroom interaction has examined the effective role of translanguaging in supporting classroom participants to use multilingual and multimodal resources to facilitate mathematical teaching and learning (e.g. Lin & He, 2017; Mazak & Herbas-Donoso, 2015). Translanguaging scholars (e.g. Li, 2011, 2018; Tai, 2022a; Tai & Li, 2020, 2021a, 2021b, 2021c; Vallejo & Dooly, 2020) have emphasized the significance of drawing on different multilingual and multimodal resources and various sociocultural knowledge to challenge the divides between the so-called 'named languages' and the non-verbal communication cues since these resources are all part of the repertoire of meaning- and sense-making resources. Existing classroom translanguaging research (e.g. Li, 2014; Wu & Lin, 2019) has demonstrated that translanguaging offered rich affordance for improving multilingual students' metalinguistic awareness and creating a safe learning environment which built on students' funds of linguistic and cultural knowledge.

Research on mathematics education has emphasized the importance of multimodal resources in facilitating the process of teaching mathematics. Mathematics education researchers (e.g. Alibali & Nathan, 2012; Chikiwa & Schäfer, 2019; Chu & Kita, 2011)

have argued that gestures are important resources to visualize mathematics, facilitate the construction of mental representations of mathematical concepts and complement the speaker's spoken language. Nevertheless, there is a lack of research that investigates specifically how and why multiple linguistic and multimodal resources are mobilized by mathematics teachers in EMI settings which do not encourage the use of students' first language (L1) (e.g. Li, 2018, 2021; Tai & Li, 2020). More research studies are needed to uncover how mathematics teachers use different resources to challenge the monolingual EMI policy in their efforts to make mathematical knowledge accessible to multilingual students.

Based on data collected from a 2-week focused classroom observation in HK EMI secondary mathematics classrooms, this article explicates how the mathematics teacher engages in embodied enactment which entails playing out different hypothetical scenarios, verbally and physically, in order to support students in understanding the mathematical concepts and advice, and build up students' motivation in learning mathematics. In this article, we define embodied enactment as an interactional practice which refers to the participants' use of embodied resources, such as gestures and body movement alongside verbal utterances, to represent an aspect of hypothetical events. It can be considered as an interactional phenomenon in which the teacher physically creates a hypothetical context for students to understand how the L2 can be used in everyday life communicative contexts (Tai & Brandt, 2018). Classroom video data, fieldnotes, ethnographic interviews with teachers and other stakeholders, and video recordings form the main database. Multimodal conversation analysis (MCA) is carried out on the classroom-interactional data, looking at not only different languages (Cantonese and English in this case) but also spatial repertoire, the use of objects and other facilities in the classroom space. The analyses of the classroom-interactional data are triangulated with the video-stimulated-recall-interview data which are analysed using interpretative phenomenological analysis (IPA) in order to analyse the teacher's reflections on his pedagogical and interactional strategies.

1 Reconceptualizing embodied enactment from a translanguaging perspective

Translanguaging refers to the process that speakers draw on their full linguistic and semiotic repertoire to make meaning (Li, 2018). Translanguaging transcends the boundaries between different named languages and also between different modalities (e.g. speech, sign, gesture) (Li, 2018, 2020). Additionally, Li (2011) proposes the notion of 'translanguaging space' which is an interactional space enabling multilingual, multimodal, multisemiotic and multi-sensory repertoires to interact and co-produce new meanings. It is also a space for multilinguals to 'bring together different dimensions of their personal history, experience and environment; their attitude, belief, and ideology; their cognitive and physical capacity, into one coordinated and meaningful performance' (Li, 2011, p. 1223). There are a number of research studies that investigate the construction of translanguaging spaces in EMI mathematics classrooms. Tai and Li (2020) illustrate the ways in which an EMI mathematics teacher brings the students' everyday life space into

the classroom in order to transform the classroom into a lived experience for students. This allows the teacher and students to bring their funds of knowledge to the forefront which makes the mathematical knowledge more relatable and relevant to the student's everyday life experiences. Additionally, Tai and Li (2021a) illuminate the potential of playful talk in transforming the EMI classroom into a translanguaging space, which allows the teacher to bring in various linguistic and multimodal resources and different kinds of knowledge to perform a range of creative acts for facilitating mathematical learning and promoting meaning communication. A recent study by Zhu et al. (2020) has investigated the role of embodied repertoires in teaching and learning. In a study of a multi-ethnic and multilingual karate club in East London, Zhu et al. (2020) have shown how a karate instructor orchestrates various multilingual and multimodal repertoires creatively and critically to support the learning of Japanese karate terms and his teaching. The authors argue that translanguaging space is where 'all the semiotic systems are integrated and orchestrated' (p. 65) to make and communicate meaning. Zhu et al. (2020) argue that the orchestration of embodied resources and spoken words and utterances is a process of translanguaging since the notion of translanguaging emphasizes the importance of going beyond the boundaries between language and other semiotic means of communication, in social interactions.

In the MCA literature on enactment, scholars have considered enactments as a distinct form of interactional and embodied practice. Wilkinson et al. (2010, p. 58) define enactment as 'the employment by participants of direct reported speech (DRS) and/or behaviour, such as the use of gesture/body movement and/or prosody to depict to recipients some aspect(s) of a reported scene or event'. By employing DRS, a speaker can create 'a version of not only what was said but how it was produced through prosody, voice quality, body movement, and linguistic selections' (Kasper & Prior, 2015, p. 244). This allows the interlocutors to mobilize non-verbal and embodied resources to recreate the authenticity and immediacy of the reported scenes or events (Holt & Clift, 2007). Nevertheless, prior studies on DRS and enactment typically examine participants' interactions related to past scenes or events. Recent studies have further reconceptualized the notion of enactment, and they take the analytical stance that enactment should be a broader category which entails that speakers utilize both linguistic and non-linguistic resources to produce past, future and imagined scenarios with a range of characters in order to demonstrate particular ideas, instead of verbally describing them (Arita, 2018; Leyland, 2016; Sert, 2017). Leyland (2016) has investigated how a Japanese English teacher and native English-speaking teaching assistant enact possible future classroom activities involving objects that the participants have access to. By enacting a vision of a forecasted future scenario, this facilitates teachers' lesson planning discussions. Arano (2020) coins a term called 'embodied solitary confirmation' which refers to the interactional phenomenon of speakers gesticulating what they learnt from upon completion of an instruction activity. Arano argues that the process of enacting what one learnt from the instruction enables the speakers to demonstrate their understanding of the instructed tasks. Such a phenomenon supports Tai and Khabbazbashi's (2019a) argument that the interactional procedure of enactment can work as a 'window' to understand the current state of speakers' knowledge in the learning process. In the context of English for speakers of other languages (ESOL),

Tai and Brandt (2018) coin a notion of 'embodied enactment', and they have demonstrated how the ESOL teacher provides several hypothetical everyday scenarios to explain vocabulary items (e.g. 'excuse me'), thereby creating an environment to familiarize the students with the specific meaning of the vocabulary. In other words, embodied enactment does not consider gestures as a supplement or aid to the teacher's verbal explanations. Rather, embodied enactment involves 'more than simply using [one's] body to emphasize or add visual description of a concept' (Tai and Brandt, 2018, p. 262). As shown in Tai and Brandt (2018), the ESOL teacher physically creates a hypothetical context for students to understand how the target language can be used in specific situational contexts.

To date, these CA studies on enactment have focused on L2 learning contexts or everyday life social interactions. There is a need for such studies in the EMI context, as constructing embodied enactment is also relevant to EMI teachers' pedagogical practices. The present study aims to contribute to the current literature on translanguaging and mathematics teaching and learning by investigating the role of embodied enactment in creating hypothetical scenarios for achieving the teacher's pedagogical goals. In this article, we aim to argue that embodied enactment is a translanguaging phenomenon which creates a translanguaging space for participants to translanguage fluidly between registers, styles, languages, as well as across modalities in order to support meaning-making processes. By doing so, it plays a role in supporting students' mathematical thinking and motivating students' interest in learning mathematics.

2 Use of multimodal resources in mathematics learning

Prior research on mathematics education has captured the role of multimodal resources in developing students' conceptual understanding of mathematical knowledge. As Tran et al. (2017, p. 3) argue, before abstract forms of mathematical ideas are emerged, people manipulate diverse resources to solve mathematical issues in the real world. Such an argument is further reinforced by mathematics education researchers who call for future research to adopt multimodal conversation analysis in order to investigate how mathematics classrooms are interactionally organized and how specific mathematical practices are accomplished (Abrahamson et al., 2019; Krummheuer, 2011; Ingram, 2018). As argued by Krummheuer (2011), mathematical learning is locally produced in the interaction. That is, the learning of mathematical knowledge and understanding is inherently locally constructed at particular moments of classroom interactions. Future research studies in mathematics education are encouraged to investigate how different languages and modalities have different affordances for mathematics learning, making it important for researchers to explore their potential for meaning-making. This can only be investigated through a detailed analysis of teachers' and students' actual practices.

A number of research studies in mathematics education have shown how a teacher's gestures can affect students' construction of mental representations of mathematical concepts (e.g. Alibali & Nathan, 2012; Chikiwa, 2021; Chikiwa & Schäfer, 2019; Yoon et al., 2011). Chikiwa (2021) is one of the recent studies that adopt embodied cognition as a theoretical framework to understand mathematics teachers' use of gestures to foster students' learning. Chikiwa explores two grade 11 secondary teachers teaching

trigonometry for a week, and the findings illustrate how the teachers use iconic gestures to offer visual resemblances with the trigonometric concepts, including angles, triangles, height and adjacent sides. The teacher also makes use of pointing gestures to direct students' attention to the diagrams. Chikiwa argues that all forms of teacher gestures complement their use of verbal languages, and gestures can be used effectively to mediate and scaffold students' learning of mathematics. On the other hand, Yoon et al. (2011) explore how two mathematics secondary teachers in New Zealand use gestures to communicate mathematical concepts and create a physical mathematical gesture space for mathematical learning. The findings demonstrate that teachers use different gestures to visualize and make sense of the mathematical features of the anti-derivative graphs that they construct. It is argued that the creation of mathematical gestures can enable students to travel from context-embedded mathematical thinking to more abstract kinds of mathematics. A recent literature review conducted by Tran et al. (2017) highlights the impact of technology on affecting teacher's and students' embodied activities. The review concludes that the accessibility of technology, such as digital touch screens and interactive whiteboards, can improve the teacher's pedagogical methods for embodied learning of mathematics. However, teachers need to be aware of how to integrate technology effectively for enhancing students' mathematical learning since not all embodied resources are useful for teaching all mathematical concepts to all students. Such an argument is also reflected in a recent study by Tai and Li (2021c). Although the authors have demonstrated the affordance of iPad in allowing the EMI mathematics teacher to create a technology-mediated translanguaging space, they argue that 'such a technology-mediated space may not be always perceived as a safe atmosphere in the classroom' (p. 47), and, for example, an iPad must be used with clear pedagogical intentions. In the analysis of the interaction, they have shown how the teacher uses the iPad's camera function to take photos of students in order to create a humorous atmosphere. Nevertheless, it can be suggested that the teacher is creating an unsafe space for students whose pictures are being taken since such an action could dampen the students' self-esteem, which may trigger fear or depression. Hence, it is necessary for mathematics teachers to harness the available linguistic, semiotic and spatial repertoires strategically and appropriately in order to achieve his/her pedagogical goals.

3 EMI in HK

The nature of EMI policy goes against the notion of translanguaging, which challenges the necessity of only using one named language (L1 or L2) as the medium to teach subject matters such as mathematics. The EMI policy has been implemented in HK which restricts teachers and students to use English-only in the classroom, which may hinder students from drawing on their knowledge and skills in their L1 and restrict opportunities for teachers and students with shared linguistic and cultural backgrounds to communicate effectively (Lin, 2019; Lin & He, 2017). As Li (2021) argues, the promotion of English 'as the language of science, knowledge, and internationalization is an ideological act' (p. 178), and such a monolingual policy contributes to the institutionalization of linguistic and social inequalities.

HK is a uniquely suitable context for this study because English, being the official language of the former colonial era and current international language, is economically valued in HK's society, and there is a strong preference for EMI among parents and students because EMI schools are perceived to be more prestigious and allow students to acquire English more effectively (Choi, 2003; Tollefson & Tsui, 2014). The selection of medium-of-instruction in the educational system has been a highly controversial issue in HK, where the majority of the citizens speak Cantonese as their L1. Under the latest medium-of-instruction policy in 2010, the government implemented the fine-tuned medium-of-instruction policy by allowing Chinese-medium-instruction schools that have met certain requirements to have some approved EMI classes (Lo & Lo, 2014). As a result, lots of secondary schools are teaching at least some subjects through EMI. A rough estimation based on the Secondary School Profile in 2019–2020 indicates that around 30% of secondary schools adopt EMI throughout all the grades and approximately 40% adopt EMI for at least one academic subject.

Several research studies have suggested that adopting EMI in secondary schools provides limited opportunities for students to participate in classroom interaction. This is because the English-only rule prevents students from using their familiar languages to respond to the teacher's questions or self-initiate turns in classroom interactions. In addition to the language barrier imposed by the EMI policy, HK mathematics education researchers have identified features in the traditional mathematics teaching practices in HK EMI classrooms that limit opportunities for students to participate in classroom discussions. It is suggested that EMI teachers tend to adopt the lecture format to teach the subject (Tollefson & Tsui, 2014), and most of the teacher-talk time focuses on demonstrating solutions to mathematics problems, with little employment of multimodal resources beyond blackboard and chalk (Mok, 2019). Lo (2014) suggests that EMI mathematics lessons may not promote classroom interaction between the teacher and students. Lo argues that this is possibly because the lessons typically involve solving mathematical equations and following calculation procedures. As Mok (2019) argues, although the HK mathematics curriculum has recognized the importance of students' participation in the process of mathematics learning, mathematics teachers remain the important people in charge of the classroom events, and the teaching is often guided by the teacher and by the tasks in the lessons.

Nevertheless, recent research on EMI mathematics classrooms (e.g. Tai & Li, 2021a, 2021b, 2021c) has demonstrated how EMI mathematics teachers creatively employ various linguistic and multimodal resources to transform the traditionally teacher-fronted interaction and create a space to engage students in learning mathematics and encourage students to develop positive attitudes towards mathematics learning. This, in turn, constructs a more dynamic and contingent environment to facilitate students' participation (Baynham, 2006; Bowden et al., 2022; Lee, 2010). The research findings observed by Tai and Li suggest the need for researchers to move away from the narrow view of EMI mathematics classrooms, which provide limited opportunities for students to interact with the teacher, to a perspective of a creative and socially oriented classroom which prioritizes developing students' mathematical understanding. As highlighted by Chronaki (2000), there is a growing number of students who become

disinterested in learning mathematics in schools, due to the fact that learning mathematics becomes irrelevant to students' personal lives. Chronaki (1998, 2000) argues that there is a need for mathematics teachers to structure their classroom interactions for empowering students to acknowledge and utilize mathematics meaningfully in their lives. In the current study, it is evident that the teacher takes mathematics as procedural and formulaic to memorize, as it is the traditional approach in HK secondary mathematics education: stressing memorization and practising mathematical skills (e.g. Leung, 1995; Lo, 2014; Mok, 2019). Nevertheless, the teacher's use of translanguaging strategies and bringing everyday life knowledge into the classroom is an important first step towards reconceptualizing mathematics teaching in this specific EMI context. To date, there are limited research studies that explicate translanguaging practices in EMI mathematics classroom interactions (Tai & Li, 2020). Hence, this article aims to fill in the research gap by showing how the EMI mathematics teacher constructs hypothetical scenarios through embodied enactments in order to create a translanguaging space that engages students in learning mathematics and going beyond the traditional emphasis of demonstrating solutions of mathematics problems.

II Data and method

The participating school is a prestigious EMI secondary school in HK and it offers education from year 7 to year 12 based on the curriculum guides set by the HK Education Bureau. The school uses EMI to deliver most of the lessons, and the school examinations are conducted in English (except Chinese, liberal studies and Putonghua). Although the school's mission statement explicitly states the aim to develop students to be multilinguals, the school language policy places heavy emphasis on the use of English on the school campus in order to create a rich English learning environment for all students. For instance, all morning assemblies and staff meetings are conducted in English. Moreover, English-for-all-day is held every Monday where everyone (all teaching staff and students) in school must use English for communication in order to prepare students to interact effectively with other individuals from other countries.

The mathematics teacher has at least eight years' experience in teaching mathematics in English. The teacher is an L1 speaker of Cantonese and previously attended an EMI school for his secondary and university education. English is his L2 and he has a limited level of Mandarin/Putonghua proficiency. During his undergraduate studies, he occasionally taught drama at several HK secondary schools. He did not receive any specific EMI teacher training while he was pursuing his education degree.

During the two-week classroom observation, the first author observed a year 9 class. There were 18 students in the class and this class was classified as an enhancement class. Students who ranked below average in their cohort in the internal mathematics examination were enrolled in this class. All students had received at least six years of primary education, where Cantonese was employed as the medium of instruction and English was taught as an L2. All students in the class spoke Cantonese as their L1 except two students. The two students spoke Mandarin/Putonghua as their L1s and Cantonese and English as their additional languages, and they were migrants from

mainland China. A total of 11 40-min lessons were observed and video-recorded in April 2019.

A semi-structured interview, which lasted for an hour, was carried out with the teacher in order to understand his perceptions regarding teaching mathematics in EMI settings and his attitude towards using multiple languages in the EMI mathematics classrooms. Ten ethnographic interviews were conducted with the teacher during the two-week observational period in order to better understand the observed lessons. Each ethnographic interview lasted for approximately 10 minutes and ethnographic interviews were carried out while the first author was walking back to the staff room with the participating teacher. These ethnographic interviews are meant to complement what we observe in the EMI classrooms and provide the teacher with an opportunity to reflect on his own practices and attitudes (Rampton, 2006; Spradley, 1979). Three post-video-stimulated-recall interviews were conducted with the teacher in order to compare his actual translanguaging practices and his interpretations of the practices.

This study integrates MCA and IPA to study the functions of translanguaging practices in EMI mathematics lessons (Tai, Forthcoming). MCA 'focuses on how social order is co-constructed by the members of a social group' (Brouwer & Wagner, 2004, p. 30) through fine-grained analysis of the social interaction. It takes an emic/participant-relevant approach (Markee & Kasper, 2004) in order to explicate the detailed process of how social activities, such as learning, are co-organized and achieved through talk-in-interaction. Using MCA to analyse mathematics classroom interactions enables us to understand what it means to learn mathematics, do mathematics and understand mathematics. The micro-analysis of the interaction also opens up opportunities for researchers to identify how mathematical learning is achieved through the mobilization of different languages and multimodal resources. The data are transcribed using Jefferson's (2004) and Mondada's (2018) transcription conventions (see Appendix 1). In the analysis, although we use conventional linguistic labels, such as L1 and L2, to describe the named languages that the participants know, the analytical focus is on empirically observable practices. Instead of demonstrating which named languages to use in a particular classroom moment, we wish to reveal how speakers use their linguistic and multimodal repertoire from which they select resources to achieve their communicative goals (Zhu et al., 2020). The first stage of analysis involved taking a stance of 'unmotivated looking' (Mori, 2004) as the guiding principle when reviewing the video-recordings. The first author watched multiple classroom videos with an open mind (i.e. without any particular interest in research focus) to discover any interesting interactional phenomena that are worthy of further exploratory analysis. After transcribing the data, both the first and second authors carried out line-by-line analyses to closely investigate various sequences-of-talk that entailed the teacher mobilizing diverse resources to facilitate students' imagination of a scenario. In order to ensure the reliability of the analysis, we made use of the next turn proof procedure and participant orientation for validating the analyst's claims. In other words, we as analysts were required to make observations based on the participants' observable orientation and understanding.

The framework of IPA was also employed to examine how the mathematics teacher made sense of his own pedagogical practices at specific moments in the interaction and how the classroom interactions were shaped by multiple sociocultural factors. IPA

acknowledges the investigation of the meanings of the participants' experiences as an interpretative enterprise on the part of both researcher and participants. A dual interpretation process called 'double hermeneutic' is involved, and this requires researchers to take an emic approach in order to make sense of the participants trying to make sense of their world (Smith et al., 2013). Both authors conducted the IPA analysis together and we followed the analytical stages suggested by Smith et al. (2013), moving from a descriptive level to a more interpretative level. In order to enhance interpretative validity, iterative coding with constant comparison was conducted. This process involved us constantly checking our sense making against what the participating teacher had actually said in the interview.

III Analysis

In the analysis, we will present three examples of how the EMI teacher constructs embodied enactment for achieving his specific pedagogical goals. These extracts are representative of instances of the interaction. The analysed extracts are interrelated to illustrate the typical instances of translanguaging practices in the EMI classroom which construct hypothetical scenarios for facilitating mathematics learning and arousing students' interest in mathematics (ten Have, 1990). The goal of MCA analysis is to identify the interactional phenomenon in the social interaction, rather than justifying the best possible representative extracts (ten Have, 1990). Therefore, as long as the selected extracts can address the research questions to reveal the relevant 'orderliness' with their representative nature, it can be said, to a large extent, that the representativeness is sufficient, or the research findings can be reliable.

Extract 1: Creating a hypothetical scenario of computer war games

The mathematical question in Extract 1 requires students to determine the time when the aircraft will be detected by the radar. This mathematical question aims to assess students' ability to solve trigonometric problems involving bearings. The question presents two locations (points A and B) which are 100 km apart. The compass bearing of B from A is N75°E. The figure indicates an aircraft which departs from point B and flies at a speed of 150km/h along S50°W. The first question requires students to identify whether the aircraft will be detected within 50 km from point A. The second question requires students to determine when the aircraft will be detected after departing from point B. Students are expected to give their answers correct to the nearest second. In order to answer this question, the operative processes of addition, subtraction and division will be involved in the search for the answer.

In Extract 1, the teacher (T) read out the key information of the question in English, and he drew out the diagram on the blackboard. He then employed Cantonese to ask students to determine when the aircraft would be detected.

133 T: +咁邊一點會俾人 detect 啊 (7.4)+ so many points right?
((tr. so at which point will it be detected))
+T draws several small 'x' on the line---> #1
--->+

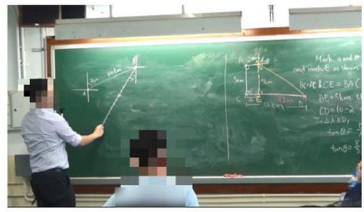


Figure #1

134 (0.5)
135 T: when the +plane fly along this line okay +like △this?
+T curved his ring and middle fingers and had the thumb, index and little fingers straightened out #2
+T moves his LH hand along the line from low to top position along the straight-line
+T walks to his LHS
△T curved his ring and middle fingers and had the thumb, index and little fingers straightened out ---> #3

Figure #2

Figure #3

136 +(0.3)
+T moves his RH hand along the line from the top to low position along the straight-line -->
137 T: okay?+
--->+
138 (0.7)
139 T: +which point (0.5) it +will be +detected?
+The school bell rings
+T moves his arm backwards and moves his RH from low to top position along the straight-line #4
+T moves his RH from top to low position along the straight-line

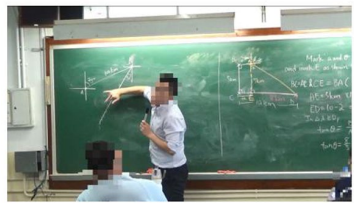


Figure #4

140 +(2.5)
+T moves his arm backward and moves his RH from low to top position along the straight-line
141 T: +會唔會中到呢△ (2.0) okay?
((tr. will it be attacked))
+T moves his RH from top to low position along the straight-line
--->△
142 (1.2)
143 T: +係邊一個 moment 你覺得會中到
((tr. at which moment do you think that it will be attacked))
+ T straightened out his index finger
144 (0.5)
145 T: +或者我調返轉條問題問你呀 (0.5) 如果你有個機師
((tr. or let me rephrase my question (0.5) if you have a pilot))
+T pointing to himself using his index finger
146 (0.4)

147 T: +唔想俾佢 detect (0.4) +你最少要飛離佢幾多?
((tr. you do not wish the aircraft to be detected (0.4) how far do you need to distance your aircraft from point A))
+T points at point A on the BB
+T points at the students using his index finger
148 (0.5)
149 S1: 五十一喊呀
((tr. 51 right))
150 (0.2)
151 T: +五十一 (1.7) 啱嘅你呢個概念+
((tr. 51 (1.7) it's a correct concept))
+T points at S1--->
--->+

Extract 1. Creating a Hypothetical Scenario of Computer War Games.

In line 133, T rephrases his question in Cantonese and asks students to consider at which point the aircraft will be detected. While he is speaking, T is drawing several small 'x's along the straight line (Figure 1) in order to visually illustrate the possible moments when the aircraft will be detected. After a 0.5-second silence, T repeats his questions in English, 'so many points right?', which possibly allows students to better understand his question. However, no student responds to T's question during the

0.5-second pause in line 134. In line 135, T continues to build on the previous hypothetical scenario, which was constructed prior to Extract 1 in order to encourage students to imagine 'when the plane flies along this line'. While he is providing the English explanation, T curves his leech finger and middle finger and straightens his thumb, index and little fingers out in order to imitate the shape of an aircraft (Figure 2). He then moves his right hand along the line from low to top position in order to visually illustrate the movement of the aircraft. After T utters 'okay like this', T enacts the same gesture from lines 136–141 to visually illustrate the shape of the aircraft (Figure 3 and Figure 4). By doing so, T is multimodally creating a hypothetical scenario of an aircraft flying along the path, and it encourages students to work out at which moment the aircraft will be detected by the tower.

It is noted that no student responds to T's question (line 140), and this is possibly due to students' shyness or their unwillingness to respond to T's question in English (Lo, 2014; Mok, 2019). In order to engage students in participating in the interaction, T repeats his question in Cantonese in lines 141 and 143 which possibly aims to make his question more comprehensible to the students. T's repetition of his question does not lead to any students' response, and this motivates T to rephrase his question and encourage students to imagine themselves having a pilot, '如果你有個機師 (if you have a pilot)' (line 145). T then continues to ask students to imagine the situation when they do not wish their pilots to be detected by the tower, '唔想俾佢 detect (you do not wish the aircraft to be detected)' (line 147). Simultaneously, T points at point A on the blackboard in order to visually specify the location of the tower. After constructing the scenario, T launches a question by asking students to predict how far the pilot needs to distance the aircraft from the tower (line 147). After a 0.5-second pause, student 1 provides an answer (i.e. 51) in Cantonese (line 149) and such an answer is accepted by T in line 151.

In Extract 1, it shows that T heavily draws on the multilingual (Cantonese and English), multimodal and semiotic resources (i.e. drawings on the blackboard and gestures) to facilitate students' imagination of a pilot preventing him/herself from being detected by the tower. Although the teacher and students are supposed to use English as the main linguistic code to teach and learn mathematics in an EMI context, the teacher chooses to employ different linguistic and multimodal resources to go beyond the top-down EMI policy that promotes a monolingual ideology in order to achieve his pedagogical goal (i.e. facilitating the teaching of a complex mathematical question) (Tai & Li, 2020, 2021a, 2021b). Such an embodied enactment supports students' understanding of the mathematical problem through bringing students' own knowledge of a pilot flying an aircraft into the classroom interaction. During the video-stimulated-recall interview, the researcher is interested to understand the rationale of T's use of gesture to visually illustrate the shape of the aircraft and move his hand along the straight line on the blackboard for indicating the movement of the plane (Table 1).

Table 1. Video-stimulated-recall interview (Extract 1).

Classroom-interaction transcript	Video-stimulated-recall-interview excerpts	Teacher's perspectives	Analyst's interpretations of the teacher's perspectives
133 T: +咁邊一點會俾人detect 啊 (7.4)+ so many points right? *((to see at which point will it be detected))* +T draws several small 'x' on the line---> #1 --->+  Figure #1 134 (0.5) 135 T: when the +plane fly along this line okay +like ±this? +T curved his ring and middle fingers and had the thumb, index and little fingers straightened out #2 +T moves his LH hand along the line from low to top position along the straight-line +T walks to his LHS ±T curved his ring and middle fingers and had the thumb, index and little fingers straightened out ---> #3  Figure #2  Figure #3 136 +(0.3) +T moves his RH hand along the line from the top to low position along the straight-line --> 137 T: okay?+ --->+ 138 (0.7) 139 T: +which point (0.5) it +will be +detected? +The school bell rings +T moves his arm backwards and moves his RH from low to top position along the straight-line #4 +T moves his RH from top to low position along the straight-line	01 K: um 仲有一個好interesting個位係呢，你特登呢隻手指呢，係咁樣 ((extending thumb, middle and last fingers, index and ring fingers pointing downwards)) ((tr. A very interesting moment is that your finger was like)) 02 T: 咁樣係 ((extending thumb, middle and last fingers, index and ring fingers pointing downward)) hahaha 飛機 ((tr. like this. Hahaha. A plane.)) 03 K: 呢個 idea 好好，in- 即係呢一，諗到呢個真係好 ((tr. This is such a nice idea! But how did you come up with this gesture?)) 04 T: hahaha 05 K: 好叻啊真係，因為你知，我可以就咁用隻手指，即係 index finger 咁樣去指㗎嘛 ((tr. You could have just used your index finger to point at the blackboard.)) 06 T: 哦 ((tr. oh)) 07 K: 點解唔可以諗，er ((tr. so what's the point?)) 08 T: hahaha 我都唔知點解喎，點解啊，我，我以前有睇個套卡通片呢啲飛機真係咁樣嘅 ((extending thumb, middle and last fingers, index and ring fingers pointing downward)) ((tr. Hahaha I didn't pay attention to that. Um I used to watch a cartoon and the aircraft looked like that.))	T's recall of the cartoon that he used to watch in the past Motivated T to use gestures to adopt the shape of the plane in this cartoon. Specifying the name of the cartoon.	Researcher's questions why T uses such hand gestures to illustrate the shape of the plane. Questioning T and inviting him to consider other ways of pointing.

(Continued)

Table 1. (Continued)

Classroom-interaction transcript	Video-stimulated-recall-interview excerpts	Teacher's perspectives	Analyst's interpretations of the teacher's perspectives
 Figure #4 140 +(2.5) +T moves his arm backward and moves his RH from low to top position along the straight-line 141 T: +會唔會中到呢A (2.0) okay? *((tr. will it be attacked))* +T moves his RH from top to low position along the straight-line --->a 142 (1.2) 143 T: +係邊一個 moment 你覺得會中到 *((tr. at which moment do you think that it will be attacked))* +T straightened out his index finger 144 (0.5) 145 T: +或者我調返轉頭問題問你呀 (0.5) 如果你有個機師 *((tr. or let me rephrase my question (0.5) if you have a pilot))* +T pointing to himself using his index finger 146 (0.4)	09 K: Hahahaha 10 T: 真係嘅，即係嗰個 macross 嗰個系列，超時要塞嗰個系列，啲飛機呢 ((tr. It's true. It's the aircraft in Macross.)) 11 K: 咩咩咩系列話 ((tr. what?)) 12 T: Macross seven ，等我 search 俾你 haha macross 日本嘅卡通片嚟，er 日本嘅動漫嚟嘅 macross seven ((tr. Macross seven. Let me search it for you. It's a Japanese cartoon.)) T is searching a photo via his phone		
147 T: +唔想俾佢 detect (0.4) +你最少要飛離佢幾多? *((tr. you do not wish the aircraft to be detected (0.4) how far do you need to distance your aircraft from point A))* +T points at point A on the BB +T points at the students using his index finger 148 (0.5) 149 S1: 五十一喊呀 *((tr. 51 right))* 150 (0.2) 151 T: +五十一 (1.7) 唔嘢你呢個概念+ *((tr. 51 (1.7) it's a correct concept))* +T points at S1--->+ --->+	13 T: 然後佢入邊啲，因為我鍾意呢個，啲嗰個飛機呢 ((tr. I really like the aircraft in the cartoon.)) 14 T: 因為嗰個飛機呢嗰個樣呢，真係類似咁樣嘅，我好鍾意嘅呢一套劇集，咁所以 ((tr. So the shape of the aircraft looks like this. I really like this series of cartoon. So yeah.)) 15 K: 哇你都，你都好 follow 呢啲喎，你真係 ((tr. Wow, I see.)) 16 T: 細個睇卡通片嗰時成日睇 ((tr. I used to watch this cartoon when I was a child.)) 17 K: 哦 ((tr. Right!)) 18 T: 所以我就，即係我每次要用飛機我都會咁樣做呢個形式嚟顯示 ((extending thumb, middle and last fingers, index and ring fingers pointing downward)) ((tr. So whenever I need to use gestures to imitate the shape of a plane, I will use this way to represent an aircraft.))	T expressed his personal interest in the plane which appeared in the cartoon. T expressed his personal interest in this cartoon. Clearly states that this cartoon is part of T's childhood memory. T states that the cartoon inspires him to use gestures to represent the feature of this particular plane from the cartoon.	T's personal interest in this particular plane and this cartoon shape his use of gesture in representing a plane in the classroom. T's childhood memory shapes his use of gestures in representing a plane in the classroom.

The researcher first questions T's rationale for using that particular gesture (i.e. Figure 2) to illustrate the shape of the aircraft. This is because the researcher believes that using an index finger to point at the straight line on the blackboard could also draw students' attention to the straight line. T then mentions a cartoon called 'Macross Seven' that he previously watched. 'Macross Seven' is a Japanese science fiction cartoon, and the theme of this cartoon is space war. Particularly, he is impressed by the plane in the cartoon and this motivates T to use gestures to adopt the shape of the plane, '因為我鍾意呢個，啲嗰個飛機呢 (because I really like the plane) (line 13)'. T also further comments that such a cartoon was part of his childhood memory, '細個睇卡通片嗰時成日睇 (I always watched this cartoon when I was a child)' (line 16). Hence, it can be argued that T's particular interest in the plane and his childhood memory of this cartoon inspires him to use gestures to imitate the shape of the plane. This also explains why T chooses to use this gesture to represent a plane, '我每次要用飛機我都會咁樣做呢個形式嚟顯示 (whenever when I need to illustrate a plane, I will use this gesture to represent it)'. It is observable in the MCA analysis that T makes use of his thumb, middle and last fingers to visually illustrate the shape of an aircraft, which is similar to the plane in 'Macross Seven' (Image 1). T extends his thumb and last fingers in order to mirror the wings of the aircraft, and the middle finger represents the aircraft's fuselage.

Image 1. Aircraft in 'Macross Seven'.

Thus, such creative use of gestures, accompanied by the teacher's use of multilingual resources, shapes the construction of the hypothetical scenario of a pilot driving an aircraft in order to help students to understand the complexity of the mathematical question on bearings. It can be argued that the production of an embodied enactment, involving the mobilization of a gesture of an aircraft and multilingual utterances, provides a translanguaging space for T to bring his personal interest in the cartoon and his childhood experience into the classroom. It is a translanguaging space which allows classroom participants to reveal their knowledge and experience of the social world in order to negotiate and create new meanings.

Extract 2: Creating a hypothetical scenario about securing a nation

Extract 2 is the subsequent part of the interaction in Extract 1, a day after Extract 1. Prior to this extract, T is continuing with the explanation of the same mathematical question. In this extract, T is engaging in an extended discussion with students after the students understand the answer to the question.

01 T: okay (0.5) 即係一千
((tr. this means one thousand))
02 (0.4)
03 T: 五百三十四秒先會有架飛機就會俾人 detect 到啦
((tr. the plane will be detected within five hundred and thirty-four seconds))
04 (0.7)
05 T: 如果你係國防部長+你就要點啊 (2.4) +係咁多秒之前就好決定係啦
((tr. if you are the secretary for national security, what would you do))
((tr. you need to make a decision within seconds))
+T enacts a salute gesture ((T raises up his RH above his head, palm facing T's face, fingers extended. Then T flips his RH, palm facing outward and stretches out his RH and moves his RH downward to leg position))
+T points at the solution "1534" on the BB
#5

Figure #5

06 (0.3)
07 T: 擊唔擊落去啦
((tr. to attack or not to attack))
08 (0.5)
09 T: $okay?$ (1.0) 明唔明你要計埋你自己嘅導彈可以幾快喎 (0.8) okay?
((tr. do you understand that you also need to calculate how fast the missile can fly))
10 (0.3)
11 T: so it's +all about math (0.5) okay
+T holds up his RH at chest level, palm facing upward
12 (0.2)

13 T: very beautiful right?
14 (0.2)
15 T: you need to do calculations (0.4) 係呀但哋由+見到架飛機開始=
((tr. yeah from the moment they notice the plane))
+T points at the BB
16 T: =+就可以計㗎啦(0.4)係呀 hahaha(0.2)就即刻攞張紙筆出來
((tr. they need to start doing the calculations))
((tr. yeah))
((tr. immediately take out the paper and pen))
+T enacts the writing gesture ((RH palm facing down, holding the chalk and move the chalk forward and backward)) #6
+T slightly leans over the desk

Figure #6

17 (0.2)
18 T: cosine (0.2) sine (0.2) +唔係 +helper 唔該(0.3)但就開始寫=
((tr. nope))
((tr. please (0.3) he/she will start writing))
+T stretches out his RH and extends it to his RHS
+T bends his fingers quickly upwards and holds his RH up, palm facing upward

19 T: =+部長你仲有十秒+咋 (.)你仲有十秒+就要計完 (0.3)就要啡唔啡但呢
((tr. Secretary, you still have ten seconds left))
((tr. you need to finish calculating within ten seconds))
((tr. should we attack or not))
+T looks down and directs his gaze on his desk
+T switches his gaze to his students
+T first moves his RH upward then downward, palm half-cupped ((as if pressing a button)) #7

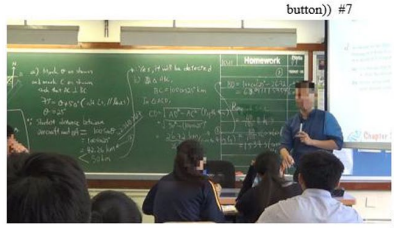


Figure #7

20 (0.3)
21 S11: +唔係總部去打個喎=
((tr. should be the headquarter making the call))
+T looks at S11
22 T: =+總部啊(.)>唔該我想△要求攻擊指令(0.2) 啦仲有十秒你要答我<=
((tr. headquarter (.) please I wish to seek for an attack order))
((tr. you still have ten seconds to reply))
+T enacting the action of picking up a phone call ((T raises up his RH at chest level, extends his thumb and little finger and bunches his index, middle and ring fingers))---> #8
△T moves his RH forward and then backward

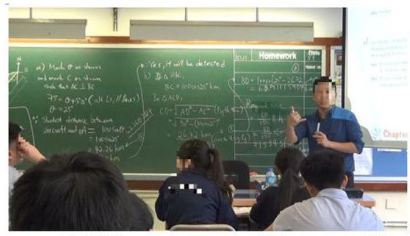


Figure #8

23 T: =有聽電話+ (.) +okay (.) 搞掂 (0.4) +飛過左
---->+
((tr. didn't pick up the call))
((tr. done))
((tr. the plane has flown over))
+T lowers his RH to the desk position
+T moves his RH from his RHS to LHS across his chest #9

Figure #9

24 (0.7)
25 T: +okay 就係咁 haha
((tr. that's it))
+T holds up his RH, palm facing upward
26 (0.6)

27 S11: 係囉 (0.3)°計完都過咗啦°=
((yeah (0.3) the plane has flown over after finishing the calculation))
28 T: =+係呀計完都過咗+(0.8)就俾人攻擊左
((tr. yes the plane will fly away after finishing the calculation))
((tr. that's how the headquarter is being attacked))
+T looks at S11
+S9 raises up his RH
29 (.)

Extract 2. Creating a Hypothetical Scenario about Securing a Nation.

In lines 1–3, T reiterates the answer in Cantonese and explains that after 1,534 seconds, the plane will be detected by the radar. In line 5, T asks a rhetorical question in Cantonese to invite students to imagine themselves as secretary for national security, '如果你係國防部長+你就要點啊 (if you are the secretary for national security, what would you do)'. This is accompanied by his enactment of a salute gesture in order to facilitate the construction of the hypothetical scenario. After a 0.7-second silence in line 5, T points at the answer on the blackboard (i.e. 1,534 seconds, Figure 5) and verbally explains to students that they have to decide within 1,534 seconds in terms of their decision of attacking the aircraft (lines 5–7). Before T further elaborates on the hypothetical scenario, he first utters '$okay?$' (line 9) in English and then switches back to Cantonese

in order to ensure students understand his messages. T explains in Cantonese that students need to calculate the speed of the missile in order for it to attack the plane (line 9). Subsequently, T switches back to English to highlight the significant role of mathematics in assisting the secretary to plan a decision, 'so it's all about math okay . . . very beautiful right?' (lines 11–13).

In lines 18–19, it is evidenced that T switches from an instructional frame to a hypothetical frame for constructing an embodied enactment. In line 18, T imagines himself as the secretary calculating how fast the missile can be launched to attack the aircraft. This is illustrated as he utters the English mathematical terms, 'cosine (0.2) sine', to pretend that he is considering the appropriate mathematical functions to solve the equation. T then switches back to Cantonese and enacts a beckoning gesture (line 18) as he pretends to seek assistance from a helper, '唔係 (.) helper 唔該 (no helper please)', in order to make the scene more dramatic.

In line 19, T mobilizes linguistic and non-linguistic cues in order to switch between the character views of a secretary and the assistant. T first imagines himself as the assistant who is offering verbal advice to the secretary: '部長你仲有十秒咋 (.) 你仲有十秒就要計完 (Secretary, you still have 10 seconds left, you need to finish calculating within 10 seconds). Here, T deliberately repeats the Cantonese phrases '仲有十秒' (still have 10 seconds)' in order to stress the urgency for the secretary to finish his calculation for decision-making. While T is speaking, T is directing his gaze on his desk which enables him to enact the role of a secretary who is working on a mathematical solution. Afterwards, T enacts the gesture of pressing a button (Figure 7) and switches back to the instructional frame by inviting students to advise the 'assistant' in terms of making the decision to launch the missile, '就要啡唔啡佢呢 (should we attack or not)'.

Student 11 self-initiates a turn and questions whether it should be the headquarters launching the missile (line 21). S11's participation in the interaction motivates T to alter his narrative as he adopts the character view of the secretary (line 22). It is noted that T enacts the action of picking up a phone call (Figure 8) and uses Cantonese to imaginatively request headquarters to seek an attack order within 10 seconds. Here, T's Cantonese utterances are spoken faster to further highlight the urgency for requesting the headquarters to attack the aircraft. However, in line 23, T deliberately divides his Cantonese utterances into 'chunks', as characterized by the short pauses, in order to illustrate the unsuccessful attempt in receiving the order in time from the headquarters. This is further emphasized as he moves his right hand to his left-hand side in order to visually illustrate the plane has flown past the radar (Figure 9).

In Extract 2, T mobilizes various linguistic resources (Cantonese and English) to construct different ways of speaking, including imitating the voice of a secretary of national security and the head of national security. The use of different linguistic resources affords the teacher to switch between character views in order to create various discursive identities and make the hypothetical scenario more vivid for the students. Along with the use of linguistic resources, T also draws on diverse multimodal cues, including eye gaze, gestures and speech pace, in order to dramatically illustrate the hypothetical dialogue between a secretary for national security and his assistant (see Figure 6, Figure 7 and Figure 8). By doing so, T aims to demonstrate the purpose of using bearings in trigonometry for solving real-life issues such as safeguarding national security. During the video-stimulated-recall interview, T is invited to comment on his motivation to create such a hypothetical scenario (Table 2).

Table 2. Video-stimulated-recall interview (Extract 2).

Classroom-interaction transcript	Video-stimulated-recall-interview excerpts	Teacher's perspectives	Analyst's interpretations of the teacher's perspectives
01 T: okay (0.5) 即係一千 *((tr. this means one thousand))* 02 (0.4) 03 T: 五百三十四秒先會有架飛機我會俾人 detect 到啦 *((tr. the plane will be detected within five hundred and thirty-four seconds))* 04 (0.7) 05 T: 如果你係國防部長+你就要點啊 (2.4) +係咁多秒之前就好決定係啦 *((tr. if you are the secretary for national security, what would you do))* *((tr. you need to make a decision within seconds))* +T enacts a salute gesture ((T raises up his RH above his head, palm facing T's face, fingers extended. Then T flips his RH, palm facing outward and stretches out his RH and moves his RH downward to leg position)) +T points at the solution "1534" on the BB #5  Figure #5 06 (0.3) 07 T: 都唔駁落去啦 *((tr. to attack or not to attack))* 08 (0.5) 09 T: $okay?$ (1.0) 明嗎明你哪計埋你自己嘅邏輯可以展係嗎 (0.8) okay? 13 T: very beautiful right? 14 (0.2) 15 T: you need to do calculations (0.4) 係呀但陡由+其到架飛機開始= *((tr. yeah,from the moment they notice the plane))* +T points at the BB 16 T: =+我可以計嘢啦(0.4) 係呀 hahaha (0.2) 我即刻攞紙筆出來 *((tr. they need to start doing the calculations))* *((tr. yeah))* *((tr. immediately take out the paper and pen))* +T enacts the writing gesture ((RH palm facing down, holding the chalk and move the chalk forward and backward)) #6 +T slightly leans over the desk  Figure #6 17 (0.2) 18 T: cosine (0.2) sine (0.2) +唔係 唔話(0.3) 但我開始寫= *((tr. nope))* *((tr. please (0.3) he/she will start writing))* +T stretches out his RH and extends it to his RHS +T bends his fingers quickly upwards and holds his RH up, palm facing upward	01 K: 啊你講吓啊 ((tr. so what do you think?)) 02 T: um 講，講咗啲其實同條數即係好似唔係好有關係嘅一啲例子嚟嘅，等佢哋深刻啲個印象囉，即係有趣啲囉 haha，即係起碼佢上堂聽完之後，哦，即係點解要計呢，咁我所以，補充左句，哦 It's all it's all about math 囉，即係所有嘢其實都關 maths 事嘅，唔好講到好似唔關自己事咁樣，即係等佢哋鍾意多啲囉 ((tr. I have provided an example which has no direct relevance to the mathematical question. I think that this example can deepen their understanding and they may find it more interesting haha. At least they will understand why they need to solve this mathematical question. So that's why I said: 'it's all it's all about math.' There are a lot of things in life that are related to mathematics and it's not right to believe that mathematics has nothing to do with you. So, I want them to develop an interest in learning mathematics.)) 03 K: um 04 T: 係啦，咁就，係囉，搞下笑囉，等佢哋開心下囉，如果唔係佢哋好悶架，成日都覺得數學，啊喺度計計，死操難操，唔知乜嘢事，咁樣囉 ((tr. yeah and I try to make it funny and let them have a laugh. Otherwise, they will find it boring. They always think that mathematics is all about solving equations and drilling exam questions. They don't know what's the purpose of learning mathematics.)) 05 K: um 06 T: 係呀，咁，haha，係囉，佢，佢地 feel，覺得，呢一堂 interesting 或者 Maths 係 interesting 嘅，咁佢哋會，嗰個，我諗會大啲嘅 motivation 去讀數囉 ((tr. Yeah, so haha. Yeah. They feel that this lesson was interesting or maybe they will think that mathematics in interesting. I think they will have greater motivation to learn mathematics.)) 07 K: um! 08 T: 係啦，即係就算讀得唔好但係起碼都，即係佢哋唔係呢個材料，但係都肯讀囉 ((tr. Even though they are not good at mathematics and they don't have the talent, at least they will put in effort in learning mathematics.))	T aims to offer an example that has no direct relevance to mathematics in order to arouse students' interest and deepen their understanding of the purpose of doing maths. T aims to lighten the mood in the classroom and motivate students' interest in learning mathematics. Acknowledging the students' weak ability in learning mathematics.	T believes that the students need more support and encouragement in learning mathematics. Hence, T's strategy is to create a humorous context in order to bring mathematics to life.

(Continued)

Table 2. (Continued)

Classroom-interaction transcript	Video-stimulated-recall-interview excerpts	Teacher's perspectives	Analyst's interpretations of the teacher's perspectives
19 T: =+都長你仲有十秒+咋 (.)你仲有十秒+我要計完 (0.3)我要睇嗰陣佢呢 ((tr. Secretary, you still have ten seconds left)) ((tr. you need to finish calculating within ten seconds)) ((tr. should we attack or not)) +T looks down and directs his gaze on his desk +T switches his gaze to his students +T first moves his RH upward then downward, palm half-cupped ((as if pressing a button)) #7  Figure #7 20 (0.3) 21 S11: +唔係總部去打個啲= ((tr. should be the headquarter making the call)) +T looks at S11 22 T: =+總部啊 (.)>唔該我想< 要求攻擊指令(0.2) 抑仲有十秒你要答我<= ((tr. headquarter (.) please I wish to seek for an attack order)) ((tr. you still have ten seconds to reply)) +T enacting the action of picking up a phone call ((T raises up his RH at chest level, extends his thumb and little finger and bunches his index, middle and ring fingers))---> #8 ΔT moves his RH forward and then backward  Figure #8 23 T: =冇聞電話+ (.) +okay (.) 搞錯 (0.4) +換過左 --->+ ((tr. didn't pick up the call)) ((tr. done)) ((tr. the plane has flown over)) +T lowers his RH to the desk position +T moves his RH from his RHS to LHS across his chest #9  Figure #9 24 (0.7) 25 T: +okay 就係咁 haha ((tr. that's it)) +T holds up his RH, palm facing upward 26 (0.6)	09 K: um! 10 T: 係啦，就係咁 ((tr. yeah that's it.)) 11 K: um hm! 你個，嗰個 Pedagogical goal 係好 clear，我覺得好 interesting 係有幾個原因嘅 ((tr. um hm! Your pedagogical goal is here very clear and there are several reasons that make it interesting.)) 12 T: um hm 13 K: 一係即係，即係，又係雖然又係用中文，但係呢嗰個 switching between 嗰個，我哋叫做 character view 即係其實係 discourse 嗰啲野來，即係你當時 adopt 左一個 perspective 就係，呢個係一個國防部長嘅 perspective ((tr. Firstly even though you mostly rely on Cantonese, it is noticeable that you switch between character views, that is the way you adopt a perspective, which is being a Secretary for National Security.)) 14 T: um ha 15 K: 然之後用呢一種嘅 voicing 離去 construct一個，一個新嘅 identity 出嚟 ((tr. so you are adopting a voice to construct an identity.)) 16 T: 哦，我即係我，我，變咗代入左個角色 ((tr. oh so I am enacting a character.)) 17 K: 係啦係啦係啦，代，代入囉 ((tr. yes that's right. Putting yourself into the character's world.)) 18 T: uh ha, 都係嘅，因為我玩 drama 嘅，我自己以前 ((tr. uh ha that's right. That's because I used to play drama.)) 19 K: 係啦係啦，我記得你講過 ((tr. oh right I remember that.)) 20 T: 咁所以，係啦係啦，咁所以可能就咁，會即刻就搞笑啲囉 haha 等佢哋會覺得，啊，出邊望緊嗰個人係國防部，係啦，佢都咁樣做咁樣囉，hahaha，就係咁，跟住就會，佢哋會 into 啲成個 situation 囉，如果唔係 out 左， 即，做戲嗰啲 out, out 左，佢入唔到戲呀嘛佢哋，就所以， 啊係呀，呀，親歷其景，哦真係會咁樣喎，係囉 ((tr. So yeah. Perhaps it's because of my experience with drama, it makes the whole context very humorous. Haha. That can allow students to notice that: 'hey the guy out there is from the department of national security. He is also doing something similar like us.' Haha. So that they will be immersed into the whole situation. If the whole drama is not well-performed, the students won't be engaged. So yeah)).	T attributes his skills of adopting various character views to his experience of engaging in drama activities. T aims to encourage students to imagine himself as the Secretary for National Security so that they can be immersed in the hypothetical context.	The researcher acknowledges the role of switching between character views in order to construct various discursive identities. T's prior experience in drama activities enables him to adopt different discursive identities and construct the hypothetical scenario. T shifts his footing by imagining his students' reactions when they are looking at T's dramatic performance.

T argues that creating a situation related to national security can arouse students' interest and deepen their understanding of the purpose of doing mathematics. It encourages students to think about the significance of mathematics in real-life situations. He quotes an English phrase from the classroom interaction, 'it's all about math', in line 2 in order to reiterate his pedagogical goal for creating such a hypothetical context in the classroom. Moreover, T also aims to lighten students' moods and motivate students' interest in learning mathematics. In the interview, T acknowledges that the students in this enhancement class need further support and encouragement for learning mathematics. In order to achieve his goal of developing students' interest in learning mathematics, T's strategy is to create a humorous context in order to bring mathematics to life and motivate students to immerse themselves in the hypothetical context (lines 4–20). In order to successfully create the hypothetical context dramatically, it is noticeable in the MCA analysis that T enacts two characters simultaneously by using his Cantonese and English utterances, eye gazes and gestures in order to vividly depict the discursive identities of the secretary and the assistant. T attributes his skills of adopting various character views to his experience of engaging in drama activities when he was a secondary and university student. Particularly, T shifts his footing by imagining himself as his students' reactions when they are looking at T's dramatic performance, '啊，出邊望緊嗰個人係國防部 . . . 佢都咁樣做咁樣囉' (hey the guy out there is from the department of national security. He is also doing something similar like us), in order to display his goal of enabling students to immerse themselves in the hypothetical scenario. Therefore, it can be argued that T's pedagogical goal of bringing mathematics to life and also his prior experience in acting shape his embodied enactment in adopting different discursive identities and constructing the scenario accordingly.

Extract 3: Enacting a moment of fighting

In Extract 3, students need to find the coordinates of a point through the condition for parallel lines. Specifically, students are asked to draw on the equation for calculating the length of a slope (i.e. $m=(Y2-Y1)\div(X2-X1)$). Students are expected to first substitute the coordinates of a point into the equation and subsequently follow the operational process of subtraction and division in order to generate the value of the slope.

The mathematical question provides three points (A, B and C) to students. Each point involves the values of *x*-axis and *y*-axis. The three points A (1, 7), B (4, 5) and C (3, 2) are provided. The first question requires students to find the slope of BC. The second question involves students in searching for the coordinates of D if the straight line passing through point A and parallel to BC intersects the *y*-axis at point D.

Prior to the extract, student 4 (S4) pointed out that inserting a formula into the calculator could allow her to obtain the same result and it was unnecessary to understand the equation. T explained that students need to show the mathematical steps when answering extended questions, similar to the mathematical question that they had to solve in class. S4 continued the debate with T, and she noted that students could use the calculator to check their answers. T agreed with S4's suggestion, and he reminded students not to rely on the calculator in case they forgot the formula when answering extended questions. In Extract 3, T is enacting a hypothetical context and pretending he is a fighter who is trying to solve a mathematical equation.

104 T: +lah bc (0.6) +d (2.0) +c (2.4) 係囉+坊間好多旁門左道嘅方法
((tr. yeah, the outside world includes lots of heterodox ways))
+T looks at the screen
+T writes '4' and '-2' on the BB
+T writes '2' and '4' on the BB
+T writes '-1/2' on the BB
105 (0.4)
106 T: +okay? (0.5) +cd
+T stretches out his right-hand arm
+T draws a straight line on BB
107 (1.0)
108 S6: 等於二
((tr. equal to two))
109 (0.6)
110 T: +cd (1.4) 咁我就唔係好識嗰啲旁門左道+嘅方法嘅 +(1.4) 係啦
((tr. so I am not familiar with those heterodox ways (1.4) right))
+T writes '2 and 4' on BB
+T writes '-4' on BB
+T writes '-1' and '2' on BB
111 (0.3)
112 T: +因為全部都係呢 (0.5) +打好過根基呢
((tr. that's because on the whole (0.5) establishing a strong basis))
+T turns his body to face the students
+T slightly kneels down #16
+T's RH at waist level, palm facing students
113 (0.5)

114 T: +然後去+對付嗰啲題目嘅係啦
((tr. in order to deal with the questions, right))
+T holds his fist
+T enacts a fighting gesture by moving his arms forward and backward continuously #3

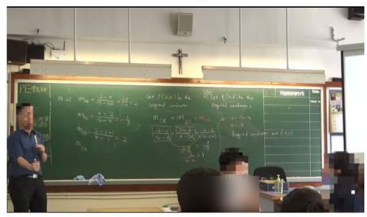


Figure #10

115 (0.8)
116 T: +好紮實嘅根基啊
((tr. a very solid basis))
+T looks at the screen

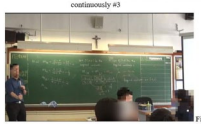
Extract 3. Enacting a Moment of Fighting.

Before T offers advice to students, T is going through a question as he utters the English letters and writes down the corresponding mathematical value on the blackboard. T then initiates a side sequence in lines 104 and 110 and switches to Cantonese in order to explain that setting a formula in a calculator is like a heterodox manner, '好多旁門左道嘅方法 (the outside world includes lots of heterodox ways)'. In line 112, when T explains the need for students to establish a strong basis for doing

mathematics, '打好過根基', T slightly kneels down and places his right hand at his waist, which potentially indicates to students that what is going to come is performative. After a 0.5-second pause, T first holds his fist and enacts a fighting gesture (Figure 10) as he explicitly mentions the need to deal with the questions, '對付嗰啲題目' (line 114). Such an enactment allows students to imagine T as a fighter who has solid training and the ability to solve mathematical questions. In line 116, T reiterates the need for a soldier to build up a solid basis for fighting in Cantonese, which signals the end of the enactment.

In Extract 3, T's embodied enactment of a fighter is represented through his use of body movements, gestures and his Cantonese utterances. By doing so, T aims to emphasize the need for students to develop a strong mathematical knowledge basis in order to address the mathematical questions easily in the examination context. In the MCA analysis, T and students portray the fact that the goal of learning mathematics is to manage school examinations through memorizing formulas. It is evident that school examination culture is apparent in the extract since students in the remedial class are expected to enhance their school mathematics examination results (fieldnotes, ethnographic interview with T), and T in this extract encourages students to understand the purpose of applying the memorized equation when calculating the value of a slope, instead of merely using a calculator to obtain the value. It can be suggested that such a vision goes against the perspective of a socially oriented mathematics classroom that prioritizes students' development of conceptual understanding. In the video-stimulated-recall interview, T is invited to comment on how the embodied enactment enables him to achieve his pedagogical goal of preparing students for the school examination (Table 3).

Table 3. Video-stimulated-recall interview (Extract 3).

Classroom-interaction transcript	Video-stimulated-recall-interview excerpts	Teacher's perspectives	Analyst's interpretations of the teacher's perspectives
104 T: +lah bc (0.6) +d (2.0) +c (2.4) 係囉+訪問好多學門左邊嘅方法 *((tr. yeah; the outside world includes lots of hatterodox ways))* +T looks at the screen +T writes '4' and '-2' on the BB +T writes '2' and '4' on the BB +T writes '-1/2' on the BB 105 (0.4) 106 T: +okay? (0.5) +cd +T stretches out his right-hand arm +T draws a straight line on BB 107 (1.0) 108 S6: 等於二 *((tr. equal to two))* 109 (0.6) 110 T: +cd (1.4) 咁我就喺係好陌嘅啲學門左邊+嘅方法嘅 +(1.4) 係啦 *((tr. so I am not familiar with those hatterodox ways (1.4) right))* +T writes '2 and 4' on BB +T writes '-4' on BB +T writes '-1' and '2' on BB 111 (0.3) 112 T: +因為全部都係咁 (0.5) +打好過根基呢 *((tr. that's because on the whole (0.5) establishing a strong basis))* +T turns his body to face the students +T slightly kneels down #16 +T's RH at waist level, palm facing students 113 (0.5)	01 K: 咁你，特登好似講到打，fighting 咁樣呢 as a soldier fighting 咁樣嘅時候呢，你係想 create 緊啲乜嘢 effect 出嚟啊 ((tr. so you deliberately showcase your act of fighting, as if you are a soldier fighting. What are the effects that you are trying to create here?)) 02 T: 等佢哋，裝備好自己囉，去對付啲題目，即係係啦做題目就好似真係去對付佢咁樣，咁你首先要有啲 knowledge，係啦，所以你要有根基，然後就去對付佢，即係等佢哋覺得有趣啲 ((tr. Hopefully students will equip themselves for dealing with the mathematical questions. So, solving a mathematical equation is like fighting against an enemy. Firstly, you need to acquire the knowledge. Therefore, you need to develop a solid knowledge base and subsequently you can attack your enemy. I try to make it interesting to the students.)) 03 K: 我都覺，我睇咗呢段片好多次，我每次睇我都喺度笑囉 ((tr. It makes me laugh every time when I re-visit this video clip.))	T explains the rationale of creating an imaginary context of a soldier fighting. T aims to make it more interesting for students to understand his advice.	The researcher is interested to know how the embodied enactment enables T to achieve his pedagogical goal. Such an imaginary context serves as a metaphor to students as they are the soldiers who will need to develop a solid knowledge base to solve mathematical equations. The researcher acknowledges the playfulness of T's creation of the hypothetical context.
114 T: +然後去+對付嗰啲題目嘅係啦 *((tr. in order to deal with the questions, right))* +T holds his fist +T enacts a fighting gesture by moving his arms forward and backward continuously #3  Figure #10 115 (0.8) 116 T: +好紮實嘅根基啊 *((tr. a very solid basis))* +T looks at the screen	04 T: haha 係啦係啦 ((tr. haha yes yes)) 05 T: 因為我自己計數都試過唔記得咗條 formula 啦，咁如果淨係，淨係靠篤機之後，係啦即係平時我，因為佢撳機嗰個次序同埋佢條 formula 係，係兩件事嚟㗎嘛，撳機你，佢入四個數字係啦，撳不停撳M 加 M 加 M 加 M 加 撳四次，佢就出，出到個答案啦，咁然後條式根本就冇出現過嗰個畫面度，咁所以佢，佢會唔記得呢樣野囉，即係會有呢一個可能，咁就係囉，話定個場景比佢聽，到時你就會發生呢啲咁嘅事啦咁樣，就避免左佢 ((tr. This is because I previously have forgotten the formula when I was trying to solve an equation. If you simply rely on the calculator, it is not beneficial for students in the long run. When students insert the 4 values in order to find out the length of the slope, the calculator will not display the whole formula on the screen for students. So, it's easy for students to forget about the actual formula. Creating such an imaginary context can alert students so that they are aware of the possible situation that may happen to them. Therefore, students can prevent making such a mistake.))	T is explaining how entering the 4 values (i.e. the values of x-axis and y-axis) can allow students to find out the length of the slope. However, T notes that it does not allow students to see the actual formula on the calculator's screen. Students may easily forget the formula and the goal of creating the hypothetical scenario is to draw students' attention to the importance of memorizing the formula.	T is drawing on his prior experience of doing mathematics. He recalls a moment when he forgot the formula when he was working on an extended question. Such an experience motivates T to create a hypothetical context in order to give a heads-up to his students.

In the interview, T first explains the rationale of creating a hypothetical scenario of a soldier fighting against enemies. T aims to make it more interesting for students to understand his advice. Metaphorically speaking, the students are the 'soldiers' who will need to develop a solid knowledge base and solve the mathematical equations accordingly. T further emphasizes the need for students to memorize the mathematical formula so that they are equipped to deal with extended questions that are related to calculating the value of a slope. Particularly, T draws on his prior experience of doing mathematics. He recalls a moment when he forgot the formula when he was working on an extended question. Such an experience motivates T to create a hypothetical scenario to give a heads-up to his students. Although T's motive to ask students to memorize the formula goes against the calls for prioritizing students' development of conceptual understanding, it can be argued that the teacher's creation of this hypothetical scenario is shaped by his prior experience of forgetting a formula when working out a mathematical question. This serves as T's motivation to remind students not to solely rely on the calculator for solving any mathematical equations.

IV Discussion and implications

The aim of this article is to examine how the teacher's embodied enactment extends his multilingual and multimodal repertoires to allow him to translanguage fluidly in order to construct hypothetical scenarios in EMI mathematics classrooms. This, in turn, facilitates students' learning of mathematical concepts (Extract 1) and develops students' interest in learning mathematics (Extracts 2 and 3). In Extract 1, it reveals how the teacher employs multilingual, multimodal and semiotic resources to create the hypothetical context of a pilot escaping from the tower in order to assist students in understanding the complex mathematical question. It is argued that the use of gestures and drawings on the blackboard plays a role in shaping the construction of the scenario of a pilot flying an aircraft. In Extract 2, the teacher uses diverse linguistic and non-linguistic cues, particularly eye gaze, pauses and gestures, to adopt two different character perspectives (i.e. secretary for national security and the assistant) for creating a hypothetical context of a secretary making an informed decision about attacking an aircraft. This allows students to understand the purpose of employing bearings in trigonometry for solving urgent issues, such as protecting the nation's security. Extract 3 illustrates how the teacher uses his bodily actions to enact a hypothetical context of himself as a fighter solving mathematical equations. The teacher's pedagogical goal here is to encourage students to apply the specific mathematical formula that they have learnt in class for solving unknown mathematical equations, rather than relying solely on the calculator. By doing so, students will draw on their knowledge base when they are dealing with difficult mathematical questions. In all extracts, the MCA analysis reveals that the teacher is engaging in embodied enactment to creatively create different hypothetical scenarios in order to achieve his pedagogical goals at specific moments of the classroom interactions.

This article demonstrates that the creation of different hypothetical scenarios through embodied enactment allows the EMI teacher to extend his multilingual and semiotic repertoires, which enables him to create a translanguaging space (Li, 2011, 2018; Tai & Li, 2020, 2021a, 2021b, 2021c; Tai & Wong, 2022; Tai, 2022a; Tai, 2022b; Tai, 2023a;

Tai, 2023b) to bridge the different language use situations in the classroom and beyond (Tai & Brandt, 2018; Tai & Khabbazbashi, 2019a; Tai & Khabbazbashi, 2019b). It is evident that the teacher puts emphasis on developing students' understanding of the procedural aspects of a mathematical question (Extract 1) and encouraging students to memorize mathematical formulas (Extract 3). Nevertheless, the teacher's translanguaging practices in Extracts 1, 2 and 3 can be viewed as creative because the teacher's translanguaging practices involve more than simply using one's body to add a visual description of a concept. Instead, the teacher physically and visually illustrates how the mathematical concepts (e.g. bearings in trigonometry in Extracts 1 and 2 and the concept of slope in Extract 3) can be related to students' familiar situations. The findings echo Tran's et al. (2017, p.3) view that 'integrating the body into the [teaching and] learning experience can, therefore, improve mathematical understanding by providing a connection between concrete referents and abstract concepts'. The MCA analysis presented in this article has demonstrated how the teacher's use of embodied enactment connects various mathematical ideas to the relevant out-of-class knowledge, which is a significant first step towards reconceptualizing mathematics teaching as creative and prioritizing in motivating students' in learning mathematics (Verschaffel et al., 2012). Specifically, the classroom extracts have revealed how the teacher's embodied enactment can function as a translanguaging practice which potentially facilitates students' learning of abstract mathematical knowledge and advice and motivates students' interest in learning mathematics. This can also potentially broaden the students' perspective as they recognize the meaning and value of academic knowledge beyond the instructional context.

In addition to drawing on diverse multilingual and embodied resources in the process of teaching mathematics, the teacher also brings diverse funds of knowledge into the creation of various hypothetical scenarios. For example, the teacher's creative use of gestures in depicting the shape of an aircraft's fuselage is influenced by his personal interests and childhood experience (Extract 1). Moreover, the teacher's prior experience with acting (Extract 2) and his experience of failing to remember the correct mathematical formula (Extract 3) also contribute to the creation of various hypothetical scenarios in the classrooms. These are the sociocultural factors that the teacher draws on which shape his translanguaging practices in the production of embodied enactments.

V Conclusion

The findings contribute to the current literature on translanguaging and EMI mathematics teaching and learning in a number of ways. Methodologically, this study demonstrates how combining MCA and IPA can help researchers to analyse how the EMI mathematics teacher creates embodied enactments through using different multilingual and multimodal resources for scaffolding abstract mathematical concepts to all students in the classroom (Tai & Li, 2020, 2021a, 2021b, 2021c). Particularly, adopting MCA enables researchers to describe how mathematics teaching and learning are achieved from the situated actions of classroom participants interacting in the classroom (Ingram, 2018). Although the study does not illustrate how the teacher's creation of embodied enactment through translanguaging can lead to positive outcomes on students' mathematical learning and L2 English development, this study aims to reveal how teachers can

bring diverse resources and different kinds of knowledge into the classroom with the aim of promoting students' understanding of mathematical concepts and developing their motivation about mathematics learning. Future research can carry out a longitudinal case study in order to examine how the teacher's use of gestural resources can extend the students' cognitive abilities in grasping abstract mathematical ideas. Pedagogically, the findings draw attention to the importance of raising EMI mathematics teachers' understanding of translanguaging practices in supporting mathematics teaching and learning. The EMI policy restricts teachers and students to use English only in the classroom, and it is not explicit on the use of semiotic tools (Li, 2020). In the study, it is revealed that the teacher uses diverse multilingual and multimodal resources to enhance students' learning even though he has no training in how and when to use them strategically. The findings offer illustrative examples of an EMI teacher's translanguaging strategies and invite pre-service and in-service teachers to think about using translanguaging for creating hypothetical scenarios through embodied enactments in their own professional contexts.

Acknowledgement

The author would also like to thank the English-medium-instruction mathematics teacher and students who participated in this study. Thanks must also be given to the anonymous reviewers who took time to give feedback on our work.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The work described in this article was supported by the UK Economic and Social Research Council (Grant Reference: ES/P000592/1).

ORCID iD


Kevin W. H. Tai https://orcid.org/0000-0002-2098-8082

References

Abrahamson, D., Flood, V.J., Miele, J.A., & Siu, Y.T. (2019). Enactivism and ethnomethodological conversation analysis as tools for expanding university design for learning: The case of visually impaired mathematics students. *ZDM Mathematics Education*, *51*, 291–303.

Alibali, M.W., & Nathan, M.J. (2012). Embodiment in mathematics teaching and learning: Evidence from learners' and teachers' gestures. *Journal of the Learning Sciences*, *21*, 247–286.

Arano, Y. (2020). Doing reflecting: Embodied solitary confirmation of instructed enactment. *Discourse Studies*, *22*, 261–290.

Arita, Y. (2018). Enactment in Japanese talk-in-interaction: Interrelationship between there-and-then and here-and-now sequential organization. *Journal of Pragmatics*, *123*, 78–101.

Baynham, M. (2006). Agency and contingency in the language learning of refugees and asylum seekers. *Linguistics and Education*, *17*, 24–39.

Bowden, R., Uwineza, I., Dushimimana, J.-C., & Uworwabayeho, A. (2022). Learner-centred education and English medium instruction: Policies in practice in a lower-secondary mathematics class in rural Rwanda. *Compare: A Journal of Comparative and International Education*. Epub ahead of print 12 July 2022. DOI: 10.1080/03057925.2022.2093163

Bozbiyik, M., & Morton, T. (2022). Transitioning between 'Outside' and 'Inside' Knowledge in an Online University EMI Chemistry Course. *Applied Linguistics*. Epub ahead of Print.

Brouwer, C.E., & Wagner, J. (2004). Developmental issues in second language conversation. *Journal of Applied Linguistics*, *1*, 29–47.

Chikiwa, C. (2021). Gestures and the spoken language: A crucial semiotic and symbolic relationship in multilingual mathematics classes. *EURASIA Journal of Mathematics, Science and Technology Education*, *17*, 1–14.

Chikiwa, C., & Schäfer, M. (2019). Visualisation processes in mathematics classrooms - The case of gestures. In Graven, M., Venkat, H., Essien, A.A., & P. Vale (Eds.), *43rd annual meeting of the international group for the psychology of mathematics education: Volume 4* (pp. 4–24). PME.

Choi, P.K. (2003). The best students will learn English: Ultra-utilitarianism and linguistic imperialism in education in post-1997 Hong Kong. *Journal of Education Policy*, *18*, 673–694.

Chronaki, A. (1998). Exploring the socio-constructive aspects of maths teaching: Using 'tools' in creating a maths learning culture. In Bjorkqvist, O. (Ed.), *Mathematics teaching from a constructivist point of view* (pp. 61–85). Abo Academi University Publications.

Chronaki, A. (2000). Teaching maths through theme-based resources: Pedagogic style, 'theme' and 'maths' in lessons. *Educational Studies in Mathematics*, *42*, 141–163.

Chu, M., & Kita, S. (2011). The nature of gestures' beneficial role in spatial problem solving. *Journal of Experimental Psychology: General*, *140*, 102–116.

Hand, V. (2012). Seeing culture and power in mathematical learning: Toward a model of equitable instruction. *Educational Studies in Mathematics*, *80*, 233–247.

Holt, E., & Clift, R. (2007). *Reporting talk: Reported speech in interaction*. Cambridge University Press.

Ingram, J. (2018). Moving forward with ethnomethodological approaches to analysing mathematics classroom interactions. *ZDM Mathematics Education*, *50*, 1065–1075.

Jefferson, G. (2004). Glossary of transcript symbols with an introduction. In Lerner, G. (Ed.), *Conversation analysis: Studies from the first generation* (pp. 14–31). John Benjamins.

Kasper, G., & Prior, M. (2015). Analyzing storytelling in TESOL interview research. *TESOL Quarterly*, *49*, 226–255.

Krummheuer, G. (2011). Representation of the notion 'learning as participation' in everyday situations of mathematics classes. *ZDM Mathematics Education*, *43*, 81–90.

Lee, Y.A. (2010). Learning in the contingency of talk-in-interaction. *Text and Talk*, *30*, 403–422.

Leung, F.K.S. (1995). The mathematics classroom in Beijing, Hong Kong and London. *Educational Studies in Mathematics*, *29*, 297–325.

Leyland, C. (2016). 'Pre-enactment' in team-teacher planning talk: Demonstrating a possible future in the here-and-now. *Pragmatics*, *26*, 675–704.

Li, W. (2011). Moment analysis and translanguaging space: Discursive construction of identities by multilingual Chinese youth in Britain. *Journal of Pragmatics*, *43*, 1222–1235.

Li, W. (2014). Translanguaging knowledge and identity in complementary classrooms for multilingual minority ethnic children. *Classroom Discourse*, 5, 158–75.

Li, W. (2018). Translanguaging as a practical theory of language. *Applied Linguistics*, *39*, 9–30.

Li, W. (2020). Multilingual English users' linguistic innovation. *World Englishes*, *39*, 236–248.

Li, W. (2021). Translanguaging as a political stance: Implications for English language education. *ELT Journal*, *76*, 172–182.

Lin, A.M.Y. (2019). Theories of translanguaging and trans-semiotising: Implications for content-based education classrooms. *International Journal of Bilingual Education and Bilingualism*, *22*, 5–16.

Lin, A.M.Y., & He, P. (2017). Translanguaging as dynamic activity flows in CLIL classrooms. *Journal of Language, Identity and Education*, *16*, 228–244.

Lo, Y.Y. (2014). L2 language learning opportunities in different academic subjects in content-based instruction: Evidence in favour of 'conventional wisdom'. *Language and Education*, *28*, 141–160.

Lo, Y.Y., & Lo, E.S.C. (2014). A meta-analysis of the effectiveness of English-medium education in Hong Kong. *Review of Educational Research*, *84*, 47–73.

Macaro, E. (2018). *English medium instruction*. Oxford University Press.

Markee, N., & Kasper, G. (2004). Classroom talks: An introduction. *The Modern Language Journal*, *88*, 491–500.

Mazak, C., & Herbas-Donoso, C. (2015). Translanguaging practices at a bilingual university: A case study of a science classroom. *International Journal of Bilingual Education and Bilingualism*, *18*, 698–714.

Mok, I.A.C. (2019). From the Confucian tradition to the digital era: The case of mathematics teaching in Hong Kong. *International Journal of Chinese Education*, *8*, 73–94.

Mondada, L. (2018). Multiple temporalities of language and body in interaction: Challenges for transcribing multimodality. *Research on Language and Social Interaction*, *51*, 85–106.

Mori, J. (2004). Negotiating sequential boundaries and learning opportunities: A case from a Japanese language classroom. *Modern Language Journal*, *88*, 536–550.

Rampton, B. (2006). *Language in late modernity: Interaction in an urban school*. Cambridge University Press.

Robertson, S.A., & Graven, M. (2020). Language as an including or excluding factor in mathematics teaching and learning. *Mathematics Education Research Journal*, *32*, 77–101.

Sert, O. (2017). Creating opportunities for L2 learning in a prediction activity. *System*, *70*, 14–25.

Smith, J.A., Flowers, P., & Larkin, M. (2013). *Interpretative phenomenological analysis: Theory, method, and research*. Sage.

Spradley, J.P. (1979). *The ethnographic interview*. Holt, Rinehart and Winston.

Tai, K.W.H. (2022a). Translanguaging as inclusive pedagogical practices in English medium instruction science and Mathematics classrooms for linguistically and culturally diverse students. *Research in Science Education*, *52*, 975–1012.

Tai, K.W.H. (2022b). A translanguaging perspective on teacher contingency in Hong Kong English Medium Instruction history classrooms. *Applied Linguistics*. Epub ahead of Print.

Tai, K.W.H. (2023a). Managing classroom misbehaviours in the Hong Kong English Medium Instruction secondary classrooms: A translanguaging perspective. *System*, 113, 1-35.

Tai, K.W.H. (2023b). Cross-curricular connection in an English Medium Instruction Western History classroom: A translanguaging view. *Language and Education*. Epub ahead of Print.

Tai, K.W.H. (Forthcoming). *Combining Multimodal Conversation Analysis and Interpretative Phenomenological Analysis: A Methodological Framework for Researching Translanguaging in Multilingual Classrooms*. London: Routledge.

Tai, K.W.H., & Brandt, A. (2018). Creating an imaginary context: Teacher's use of embodied enactments in addressing a learner's initiatives in a beginner-level adult ESOL classroom. *Classroom Discourse*, *9*, 244–266.

Tai, K.W.H., & Khabbazbashi, N. (2019a). The mediation and organisation of gestures in vocabulary instructions: A microgenetic analysis of interactions in a beginning-level adult ESOL classroom. *Language and Education*, *33*, 445–468.

Tai, K.W.H., & Khabbazbashi, N. (2019b). Vocabulary explanations in beginning-level adult ESOL classroom interactions: A conversation analysis perspective. *Linguistics and Education*, *52*, 61–77.

Tai, K.W.H., & Li, W. (2020). Bringing the outside in: Connecting students' out-of-school knowledge and experience through translanguaging in Hong Kong English medium instruction Mathematics classes. *System*, *95*, 1–32.

Tai, K.W.H., & Li, W. (2021a). Constructing playful talk through translanguaging in the English medium instruction mathematics classrooms. *Applied Linguistics*, *42*, 607–640.

Tai, K.W.H., & Li, W. (2021b). Co-learning in Hong Kong English medium instruction Mathematics secondary classrooms: A translanguaging perspective. *Language and Education*, *35*, 241–267.

Tai, K.W.H., & Li, W. (2021c). The affordances of iPad for constructing a technology-mediated space in Hong Kong English medium instruction secondary classrooms: A translanguaging view. *Language Teaching Research*. Epub ahead of print 26 July 2021. DOI: 10.1177/13621688211027851

Tai, K.W.H., & Wong, C.-Y. (2022). Empowering students through the construction of a translanguaging space in an English as a first language classroom. *Applied Linguistics*. Epub ahead of print 31 December 2022. DOI: 10.1093/applin/amac069/6966483

ten Have, P. (1990). Methodological issues in conversation analysis. *Bulletin de Méthodologie Sociologique*, *27*, 23–51.

Teo, P. (2008). Outside in/inside out: Bridging the gap in literacy education in Singapore classrooms. *Language and Education*, *22*, 411–431.

Tollefson, J., & Tsui, A.B.M. (2014). Language diversity and language policy in educational access and equity. *Review of Research in Education*, *38*, 189–214.

Tran, C., Smith, B., & Buschkuehl, M. (2017). Support of mathematical thinking through embodied cognition: Nondigital and digital approaches. *Cognitive Research: Principles and Implications*, *2*, 1–18.

Vallejo, C., & Dooly, M. (2020). Plurilingualism and translanguaging: Emergent approaches and shared concerns. Introduction to the special issue. *International Journal of Bilingual Education and Bilingualism*, *23*, 1–16.

Verschaffel, L., Van Doorden, W., & De Smedt, B. (2012). Mathematical learning. In Seel, N.M. (Ed.), *Encyclopedia of the sciences of learning* (pp. 2107–2110). Springer.

Wilkinson, R., Beeke, S., & Maxim, J. (2010). Formulating actions and events with limited linguistic resources: Enactment and iconicity in agrammatic aphasic talk. *Research on Language and Social Interaction*, *43*, 57–84.

Wu, Y., & Lin, A.M.Y. (2019). Translanguaging and trans-semiotising in a CLIL biology class in Hong Kong: Whole-body sense-making in the flow of knowledge co-making. *Classroom Discourse*, *10*, 252–273.

Yoon, C., Thomas, M., & Dreyfus, T. (2011). Grounded blends and mathematical gesture spaces: Developing mathematical understandings via gestures. *Educational Studies in Mathematics*, *78*, 371–393.

Zhu, H., Li, W., & Jankowicz-Pytel, D. (2020). Translanguaging and embodied teaching and learning: lessons from a multilingual karate club in London. *International Journal of Bilingual Education and Bilingualism*, *23*, 65–80.

Appendix 1

Multimodal conversation analysis (MCA) transcription conventions

Sequential and timing elements of the interaction

[		Beginning point of simultaneous speaking (of two of more people)
]		End point of simultaneous speaking
=		Talk by two speakers which is contiguous
	OR	(i.e. not overlapping, but with no hearable pause in between) continuation of the same turn by the same speaker even though the turn is separated in the transcript
(0.2)		The time (in tenths of a second) between utterances
(.)		A micro-pause (one tenth of a second or less)

Paralinguistic elements of interaction

wo:rd	Sound extension of a word (more colons: longer stretches)
word**.**	Fall in tone (not necessarily the end of a sentence)
word**,**	Continuing intonation (not necessarily between clauses)
wor-	An abrupt stop in articulation
word**?**	Rising inflection (not necessarily a question)
word	(underline) Emphasized word, part of word or sound
word↑	Rising intonation
word↓	Falling intonation
°word°	Talk that is quieter than surrounding talk
hh	Audible out-breaths
.hh	Audible in-breaths
w**(hh)**ord	Laughter within a word
>word<	Talk that is spoken faster than surrounding talk
<word>	Talk that is spoken slower than surrounding talk
$**word**$	Talk uttered in a 'smile voice'

Other conventions

(word**)**	Approximations of what is heard
((comment**))**	Analyst's notes
#	Indicating the exact locations of the figures in the transcripts
+	Marks the onset of a non-verbal action (e.g. shift of gaze, pointing)
XX	Inaudible utterances

Sources. Adapted from Jefferson (2004) and Mondada (2018).