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Translanguaging and trans-semiotising in a CLIL biology class in Hong Kong: whole-body sense-making in the flow of knowledge co-making

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ABSTRACT

While translanguaging research has been gaining currency worldwide, calls have been made for deepening its theorisation and providing more systematic pedagogical guidance. To contribute to this discussion, this study is informed by a fluid, distributed, dynamic process view of human meaning-making. Through a fine-grained multimodal analysis of classroom activities and interactions, it elucidates the translanguaging/trans-semiotising practices of an experienced science teacher trying out a CLIL (Content and Language Integrated Learning) approach inspired by the Multimodalities-Entextualisation Cycle (MEC) in a Grade 10 biology class in Hong Kong. Post-lesson interviews and survey indicated that such practices generated a positive impact on the students in the continuous flow of knowledge co-making. Implications of the study for furthering the theorisation and practices of translanguaging/trans-semiotising will be discussed.

KEYWORDS

Translanguaging and flows; trans-semiotising; Content and language integrated learning (CLIL); thematic pattern; multimodal classroom discourse analysis

Introduction

Translanguaging theories are underpinned by a fluid, distributed, dynamic process view of language (Canagarajah 2018; García and Li 2014; Li 2018; Lin 2019; Lin, Wu, and Lemke forthcoming) while contemporary discussions continue to revolve around the tension between fluidity and fixity in sociolinguistics theory and practice (Jaspers and Madsen 2019). Lin, Wu, and Lemke (forthcoming) bring to this discussion insights from Thibault's (2011, 2017) conceptualisation of *first-order languaging* and *second-order language* and Lemke's (2016) theorisation of *translanguaging and flows*. Thibault (2017) foregrounds the dynamic first-order processes in the here-and-now, but also attends to the interaction and integration of first-order processes with second-order cultural processes on longer timescales as follows:

> First-order languaging is an experiential flow that is enacted, maintained, and changed by the real-time activity of participants. To construe this flow as sequences of abstract forms is a radical misconstrual of what people are doing in their languaging … Bodily and situational processes in the here-and-now of first-order languaging interact with and integrate with cultural processes deriving from population scale cultural-historical dynamics (p.74).

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In Lemke's (2016) theorisation of *translanguaging and flows*, all participants involved in speech/action events (e.g. classroom teaching and learning activities), including the speakers (and their bodies), the linguistic and multimodal resources available (both physical and symbolic ones) and their past histories and ongoing developments on different timescales are all entangled and coordinated to enable the speech/action events to unfold in the dynamic flows of collective meaning-making.

Lemke (2016) and Thibault (2011, 2017)'s views thus emphasise the situated, embodied, emplaced, here-and-now locally emerging whole-body sense-making processes in the dynamic *flow* of communication. Li (2018) also espouses translanguaging as a multilingual, multisemiotic, multisensory, and multimodal practice with an emphasis on the notion of 'trans' (i.e. not just but also beyond 'languaging'). This resonates with Halliday's (2013) 'trans-semiotic' view, which Lin (2015a) has developed into the notion of 'trans-semiotising' to broaden the focus to analyse language as entangled with many other semiotics (e.g. visuals, gestures, bodily movement) in meaning-making. In this paper, we will write 'translanguaging/trans-semiotising' (TL/TS) together to indicate this intimate multi-verbal/multimodal/multisensory entanglement.

While linguists, sociolinguists, and social semiotics researchers will continue to fruitfully explore and illuminate the intimate relationships between fluid first-order processes and (relatively) stabilised second-order normative historical, cultural formations (e.g. Thibault forthcoming), our main interest in this paper is to focus on an empirical study of first-order TL/TS processes in the flow of knowledge co-making in a Grade 10 CLIL (Content-and-Language-Integrated-Learning) biology classroom in Hong Kong to illustrate the potentials of TL/TS pedagogies. As Probyn (this volume) points out, translanguaging on its own is not a sufficient condition for the learning of science (or arguably, for the learning of any subject content). In our view, TL/TS is often a locally emerging *performance* ('performance' *not* in the Chomskyan sense); however, a (breathing) space that allows for TL/TS can also be deliberately planned/built into a pedagogical design to support student inquiry and dialogic meaning-making, such as the Multimodalities-Entextualisation Cycle (MEC) developed by Lin (2010, 2015b, 2019) (see also Cenoz and Gorter (2019)'s notion of planned, pedagogical translanguaging).

In the following sections, we will first briefly review the literature on translanguaging, CLIL and the MEC, then we will present the study of TL/TS processes in a CLIL biology classroom in Hong Kong, followed by a discussion of theoretical and pedagogical implications.

Translanguaging, CLIL and the multimodalities-entextualisation cycle (MEC)

One important educational setting in which discussions of translanguaging theories and pedagogies are increasingly recognised is that of programs or approaches encompassed under the umbrella term 'Content and Language Integrated Learning' (CLIL) (Cenoz, Genesee, and Gorter 2014). CLIL is defined as 'a dual-focused educational approach in which an additional language is used for the learning and teaching of both content and language' (Coyle, Hood, and Marsh 2010, 1). A persistent challenge in these programs has been how to integrate content and language especially when the contents are cognitively demanding (e.g. abstract concepts) and the students are still developing their academic literacies and proficiency in English as their foreign language (Davison and Williams 2001; Nikula et al. 2016). Such a challenge has been particularly thorny at

the senior secondary school levels in Hong Kong, yet under-researched (Sin 2014). In light of this challenge, translanguaging has been proposed as an important scaffolding strategy for CLIL (Lin 2016). However, descriptions of such practices in the extant literature appear too general (e.g. using L1 to explain difficult concepts) to offer specific pedagogical strategies for CLIL practitioners (e.g. Lo 2015; Nikula and Moore 2019). It is against the background of these challenges that the Multimodalities-Entextualisation Cycle (Lin 2010, 2015b, 2019) has been developed.

The multimodalities-entextualisation cycle (MEC)

The Multimodalities-Entextualisation Cycle (MEC) is a curriculum genre (Rothery 1996) developed by Lin (2010, 2015b) as a heuristic tool for teachers in CLIL/CBE (Content-based Education) settings to plan their units of work or adapt it flexibly to suit their own teaching contexts. It suggests three main stages as illustrated in Figure 1.

The MEC is conceptualised as a cycle for reiteration without an end-point, i.e. speaking and writing in the school-defined target genres/registers/languages/discourses (e.g. at Stage 3) is not seen as the end point and does not occupy a more privileged status than

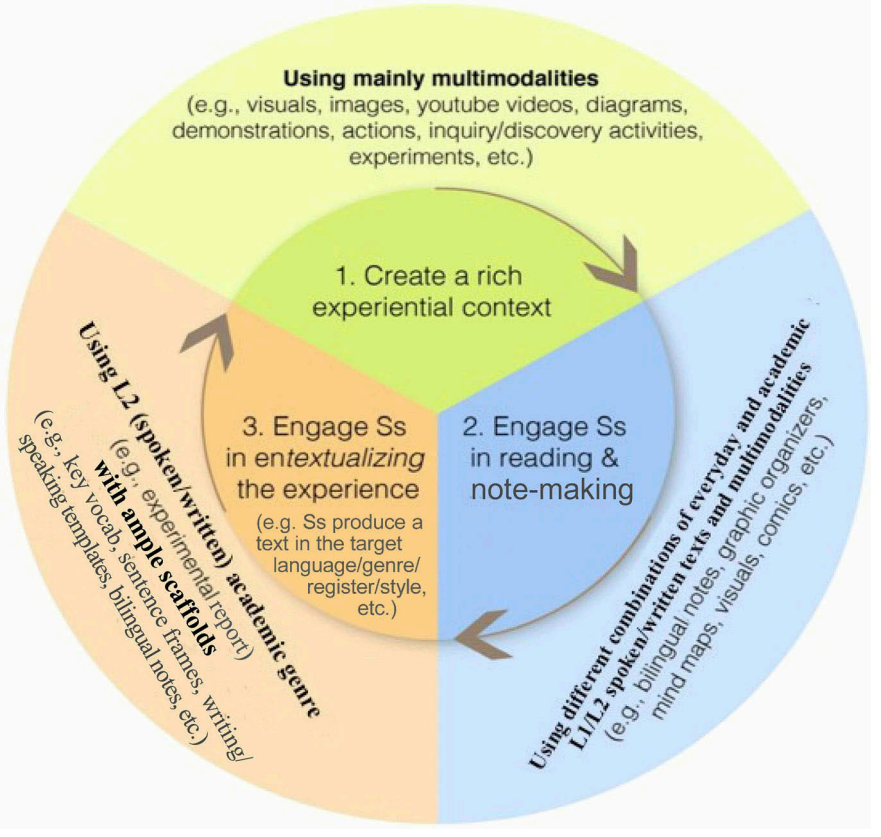

Figure 1. The multimodalities-entextualisation cycle (MEC) (Key: Ss=students) (Adapted from Lin 2010).

multimodal, plurilingual inquiry-based activities (e.g. at Stages 1–2). This idea is underpinned by the Bakhtinian dialogic, relational perspective of heteroglossia (Bakhtin 1981): The simultaneous presence of multiple discourses, voices, points of view, styles, and languages makes it possible for students to express their ideas meaningfully and expand their communicative and cultural repertoires (Barwell 2016; Turner and Lin 2017; Wegerif 2008).

The MEC is thus underpinned by the following principles (Lin 2019):

(1) *TL/TS*: Recognise TL/TS as crucial semiotic processes in the dynamic, dialogic flow of co-construal of meaning/content/knowledge;
(2) *Designed curriculum genres*: Plan for curriculum spaces for dialogic meaning-making via TL/TS; counterbalanced with a space to engage students in entextualising their understanding of content meaning in school-defined language/discourse conventions/academic genres;
(3) *A continuous, expanding rather than replacement, hierarchical model of learning*: Aim at expanding students' holistic communicative repertoires by helping them to connect their familiar everyday semiotic and cultural patterns with school-defined semiotic and cultural patterns (rather than replacing the former with the latter; also seeing the former and the latter as continuous/interwoven with each other rather than as binary poles).

Context of the study

To illustrate the potentials of the MEC (Lin 2010, 2015b, 2019) as a guide for TL/TS pedagogies, we will now examine the teaching practices of a science teacher with his Grade 10 biology class on a unit of work in a secondary school in Hong Kong. This example is selected from the ethnographic case study conducted by the first author as her doctoral thesis research which explores how the science teacher learns about and practises CLIL over a two-year period. At the time of this study, the teacher, Mr. Yeung (pseudonym), was one of the few content teachers who had the enthusiasm to do a part-time Master of Education (MEd/CLIL) program with the second author as he wants to learn how to support student learning of science in English and has been inspired by the MEC as a guide to plan CLIL lessons and TL/TS pedagogies. Fluent in both Cantonese and English, he is a very experienced science teacher with 14 years' teaching experiences in Hong Kong secondary schools and is recognised as a good teacher by his colleagues and students. The school at which Mr. Yeung has been teaching is a government-subsidised school of moderate academic standards located in a working-class district in Hong Kong. The Grade 10 biology class consists of 18 students who can be called emergent bilinguals, with Cantonese as their most familiar language while developing their general English language proficiency through the English Language Subject and varying degrees of scientific literacy in English through the Biology Subject (for a sociolinguistic background of language-in-education policy in Hong Kong, see Poon 2013).

Adaptations of the MEC in the study

The unit of work in focus is on the topic of transpiration taught in the biology laboratory classroom. It is selected for focused analysis for the following reasons: First, it is observed by the first author that the teacher's TL/TS practices in this unit are particularly rich, tactful and

continuous throughout different lesson stages. In post-lesson conversations, the teacher told the first author that he had been thinking about trying out the CLIL approach at Grade 10 based on the MEC for some time, but without lesson examples previously developed and tried out at this level, he said he could only 'try out by myself and react as it goes'. Although the teacher did not pre-plan his teaching for this unit in the form of a written lesson plan, post-hoc analysis of the lesson series using the event map approach (Green and Bridges 2018) revealed that the teaching and learning events did follow the key principles of the MEC with adaptations according to content needs (see descriptions later). Moreover, post-lesson interviews and survey show a positive impact of the TL/TS practices on the students (see descriptions later). Therefore, this will be a pioneering case for exploring the nature and potentials of TL/TS pedagogies based on the MEC. Second, the topic of transpiration is a challenging and typical one for Grade 10 biology in terms of both content and language, as the teacher told the first author; it will thus be an informative case to explore CLIL practices and if (and how) TL/TS practices contribute to knowledge construction for CLIL. Specifically, this topic not only requires students to shift between a macroscopic view and a microscopic view regarding how water inside a plant is lost into the atmosphere but also to apply several previously learned concepts to formulate a written causal explanation of transpiration pull, moving beyond simplistic thinking that water just automatically flows inside a plant.

The unit of work was taught during additional class time[1] after the final exams. As the pressure for teaching and learning was lessened in this period, Mr. Yeung and the students were relatively relaxed to try out new things. They spent three lessons on this unit on three separate days (approximately 4 hours in total), with the major lesson activities completed within one lesson session on Day 1 and consolidation work on Day 2 (two days after Day 1) and lesson review on Day 3 (in the summer class after one month). The lesson series was videotaped with a video camera set at the back of the classroom and the first author was sitting at the back of the classroom observing the lessons and taking field notes.

An overview of the teaching and learning activities in this unit is re-presented following the event map approach (Green and Bridges 2018) with adaptions (see Appendix 1 for Event Map). To facilitate a concrete understanding of the lesson activities, the following information is also listed in the event map: (a) the thematic patterns (i.e. patterns of thematic items and their semantic relationships that constitute the thematic content of a particular content area (Lemke 1990)) co-constructed by the teacher and students are listed at the bottom of each stage to illustrate the knowledge-making process; (b) key multi-semiotic and communicative resources involved in each lesson phase are listed alongside the descriptions of each phase; (c) snapshots of key activities are presented at the bottom in connection with the descriptions of the corresponding activities by arrows. It must be pointed out that these are re-presentations by the researcher based on lesson observations and subsequent analysis of lesson videotapes; the actual teaching and learning is more dynamic and less clear-cut. In other words, the MEC is a flexible model for curriculum development and the teacher is part of a locally emerging dynamic, flexible, adaptive system.

Linking to the event map, Figure 2 shows a visualisation of the adapted MEC in this lesson series, with brief descriptions of the key features of each stage and snapshots of key activities shown around each stage.

Figure 2. The MEC adapted in the lesson series.

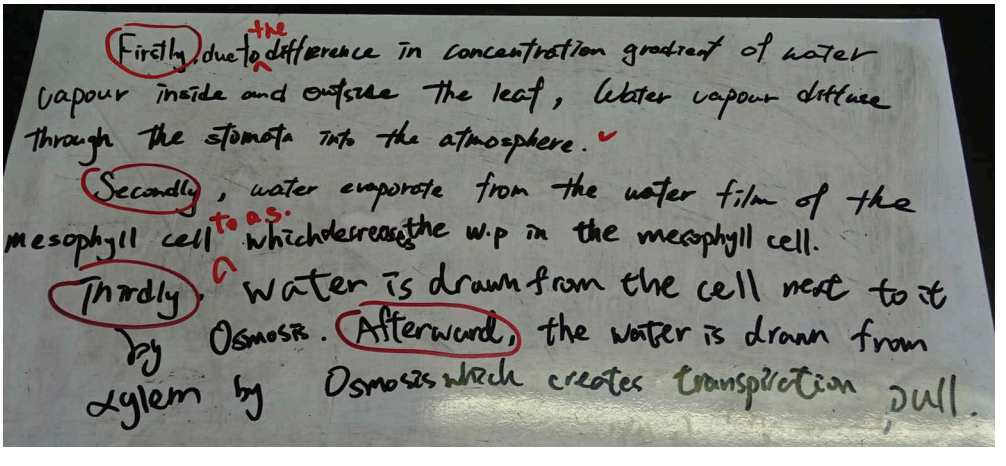

Figure 3. An exemplar of student group writing.

To illustrate the learning outcomes of the teacher's delicate TL/TS practices adapting the MEC, Figure 3 shows a sample of student group writing at the Entextualising stage (the third draft from Stage III – Sequence 3.3.2). The teacher has commented on this draft in front of the whole class making minor revisions and suggested this as an exemplar of a complete and precise causal explanation of 'transpiration pull' that the

students can follow (For this reason, this student text is put into the event map to represent the thematic nexus co-constructed at Stage III.)

As we can see from this student text, it satisfies all the five key elements that Mr. Yeung later summarised to the students as crucial to a complete and precise causal explanation of transpiration pull (i.e. a thematic nexus consisting of several thematic patterns and their semantic relations according to Lemke (1990)): (1) There are altogether four processes (corresponding to the four sentences in Figure 3), (2) happening in a sequence of interlocking cause–effect relations (i.e. one process leading to another) beginning from the stomata to the xylem, (3) with each process involving a cell structure the water passes through (i.e. from stomata, air space, mesophyll cells to xylem), and (4) driven by a mechanism corresponding to the condition in the cell structure (e.g. by diffusion at the stoma, by evaporation at the air space, by osmosis between cells), with an explanation of (5) the cause of the process (e.g. diffusion due to the difference in concentration gradient of water vapour between the inside and the outside of the leaf) or its effect leading to the next process (e.g. evaporation to the air space decreases the water potential in the mesophyll cell, thus osmosis happens between the mesophyll cell and the cell next to it). Comparing this student text with the textbook text shown in the next section, we can see that Mr. Yeung's TL/TS practices, in fact, offer a more complete and logically coherent causal explanation of the phenomenon, helping the students move beyond simplistic thinking that water just automatically flows inside a plant (see also the post-lesson student feedback presented later).

Context of the focused lesson episode

We will now turn to one lesson episode in this lesson series to illustrate the teacher's TL/TS practices. The focused lesson episode occurs at Stage III – Day 1 – Phase 3 – Sequence 3.1.1 (see descriptions in the middle part of the event map in Appendix 1) in which the teacher explicates the key thematic patterns (Lemke 1990) constituting the processes of transpiration pull through intricate TL/TS performances. It is selected for focused analysis because this sequence is a typical one among all the TL/TS practices in the lesson series and exemplifies crucial principles of the MEC (Lin 2019): connecting students' familiar everyday semiotic and cultural patterns with school-defined semiotic and cultural patterns in the dynamic, dialogic flow of knowledge co-construal through TL/TS practices.

The complete lesson sequence lasts for about 13 minutes. As space remits, here we can only analyse the most representative episode from this sequence in which the teacher explicates and *enacts* the last step of transpiration pull. To situate the analysis, we will first briefly describe what happens before and after this episode.

Prior to the Sequence 3.1.1, as can be gleaned from the event map, Mr. Yeung has gone through Stage I and II in which the students are engaged in inquiry-based multimodal, multisensory exploration to understand what is transpiration (Stage I) and the major pathway (cell structures) and mechanisms water passes through inside a plant (i.e. the four processes as shown in Figure 3) (Stage II). However, these two stages build up only parts of the target thematic patterns in note form (see discussions above regarding Figure 3); students still need to build on these to find out the interlocking cause–effect relations between the four processes and their sequencing so as to formulate a complete and

logically coherent causal explanation text of transpiration pull. This will thus be the focus of Sequence 3.1.1.

This sequence consists of two parts and the focused episode occurs in the second part: At the beginning of this sequence, Mr. Yeung draws a plant cell diagram on the blackboard and discusses the causal sequence of the four processes of water transport with the students through TL/TS dialogues and drawing arrows in the cell diagram. After this, Mr. Yeung projects the textbook section on this topic onto the screen in front of the whole class and starts to explicate and enact a causal explanation of transpiration pull step by step with reference to both the cell diagram drawn on the blackboard and the textbook section. The focused episode for analysis below illustrates the last step of this process.

Figure 4 shows the plant cell diagram Mr. Yeung drew on the blackboard, with the result of his discussion with the students regarding the causal sequence of the four processes of water transport noted down by him: In the cell diagram, five fine-line arrows are numbered in sequence from stoma (①), air space (②), mesophyll cells (3a) to xylem (③), one following another with the heads pointing towards outside the cells, together forming a step-by-step pathway of water movement inside the cell structures. The scientific term of the mechanism involved in each step is notated in English near the corresponding cell structure: 'diffusion' for ①, 'evaporate' for ②, 'osmosis' for 3a and ③.

The textbook section (Yung et al. 2014, 10–5) projected onto the class screen is shown in Figure 5. The section is entitled *How transpiration pull is created* and consists of an illustration aligned with a text. The illustration contains four parts from the left to the right: On the left is a drawing of a plant with leaves, stem and roots (shown in transparent soil). An arrow connects an insert from a leaf of the plant to a blown up drawing of the different cell structures of a leaf rendered in different colours. In the drawing, there are four fine-line arrows one following another with the heads pointing towards outside the cells, indicating the pathway of the water flow. These four arrows are each connected to a corresponding sentence numbered in a sequence of 1, 2, 3, 4

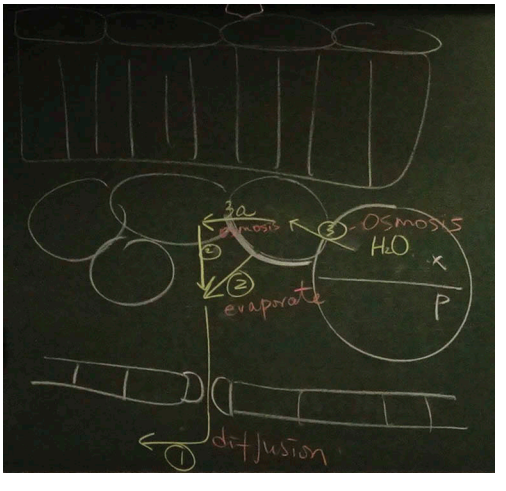

Figure 4. Teacher's drawing of a cell diagram on the blackboard.

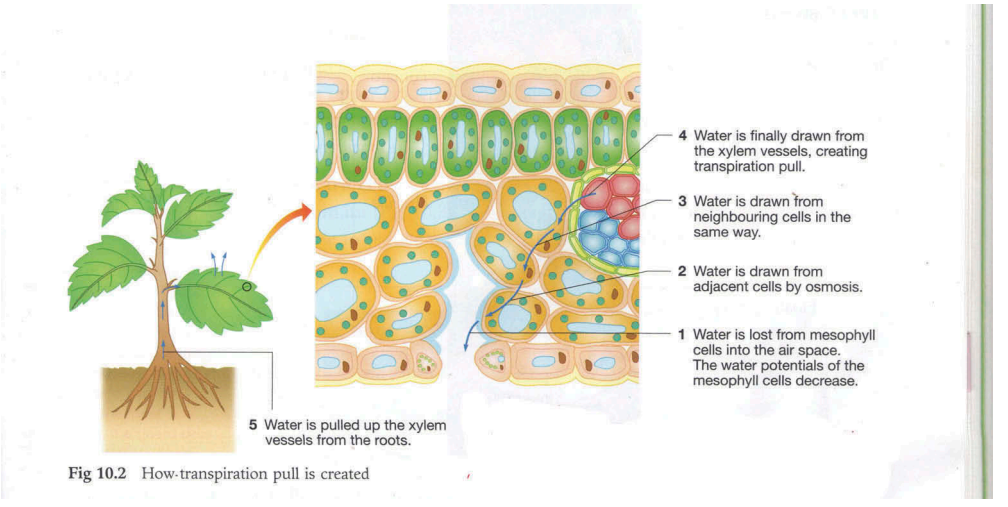

Figure 5. Textbook page projected on the screen in class. (Yung et al. 2014, 10–5. Scanned image of the page reproduced here with permission from Oxford University Press (China), Ltd.).

from the bottom to the top on the right side, with each sentence explaining one of the steps constituting the process of transpiration pull.

It is worth noting that the interlocking cause–effect relations between the four steps/sentences are not explicitly explained in this textbook text,[2] as compared with the text co-constructed by Mr. Yeung and the students (see Figure 3 and related descriptions above). However, according to Mr. Yeung, this is one of the key elements for students to grasp the explanation of transpiration pull. In other words, important semantic relations between the thematic items are not stated explicitly in this textbook text. However, we will see in the following episode how Mr. Yeung *enacts* and elucidates a more complete and logically coherent causal explanation of the phenomenon to the students through TL/TS whole-body sense-making.

After this sequence, Mr. Yeung engages students in further entextualising (i.e. drafting/crafting) what has been explained in this sequence in linkage to the textbook text into a complete causal explanation text of the processes of transpiration pull in English (see subsequent parts of Stage III in the event map).

Fine-grained multimodal analysis of the focused lesson episode

The focused lesson episode lasts for approximately 1 minute during which the teacher explicates and *enacts* the last step of the complex processes of transpiration pull and the interlocking cause–effect relations between the processes. A fine-grained multimodal analysis (Heap 1985; Kress et al. 2001) of this episode will be presented below.

This lesson episode begins with Mr. Yeung speaking in Cantonese with an embedded analogy/metaphor of 'losing water (失水)' and 'getting water (摞水)' which he has been using consistently since the beginning of Sequence 3.1.1. 'Losing water/no water (失水/無水)' are initially the students' Cantonese wordings appearing about 10 minutes preceding this episode as their answers to Mr. Yeung's question why water can move

inside a plant when they are discussing the causal relations and ordering of the processes involved in water transport inside a plant. Mr. Yeung has followed these student wordings and responded to students' answers, probing further in Cantonese using an analogy implicitly, '嗯, 無水, 咁向邊度攞水啊?' (translation: 'So yes, no water, then where to get water (攞水)?'). In the post-lesson interview, Mr. Yeung told the first author that the more scientific way of expressing this idea is because the water potential inside the cells of the plant is lower, but he thought this is a challenging topic for the students and their answers 'losing water/no water (失水/無水)' already showed good thinking towards the right direction; moreover, it was vividly related to students' daily life experiences and can be further developed following the daily life logic of 'no water – then get water' to vividly explicate the causal relations and sequencing of the processes, so he continued to draw on these wordings, pairing them up with '攞水' (getting water).

As the teacher's practices in this episode are intricately complex drawing on a variety of semiotic resources simultaneously, a multimodal transcript of the episode has been developed (See Appendix 2 for the transcript and Appendix 3 for transcription conventions) to enable concurrent reading of the speech (the first column), the accompanying multimodal features including the multimodal actions and intonational texture observed by the researcher (the second and the third columns) and the video snapshots illustrating the key multimodal features of the corresponding transcript line (the fourth column).

The phenomenon in the above episode, if analysed following traditional analysis, would probably be described as code-switching or using L1 everyday language to scaffold L2 scientific language development. However, adopting the perspectives of translanguaging/trans-semiotising as dialogic flows (Bakhtin 1981; Lemke 2016; Lin 2019), it is revealed that the use of the so-called L1 in this episode cannot be abstracted as a linguistic code (in the traditional sense); what is happening is, in fact, translanguaging, trans-semiotising, trans-registering and trans-featuring (Lin, Wu, Lemke forthcoming) happening simultaneously; that is, an embedded analogy is spoken out with Cantonese language features frequently present in the students' everyday life settings (i.e. lexical patterning, intonational texture and everyday style of talking), simultaneously interanimating (Bakhtin 1981) multi-semiotic resources which index scientific thematic patterns (i.e. visuals, gesturing, body movement and scientific terms in English) and then immediately latches onto reading aloud an expression with features of written scientific English. Through the intricate entanglement of familiar Cantonese language features, visuals, gestures, body movement and scientific English language features, a multi-semiotic world and history that is embodied in the students' daily life is evoked and repositioned: What is happening in the process of transpiration pull invisible to the naked eye (in which water is lost from plant cells and pulled up from the roots through a series of causal processes) is made analogous to the students' daily life experience, logic and series of embodied actions associated with the Cantonese lexical collocations of 'no water (無水) – then get water (攞水)' as expressed in everyday style Cantonese and the students could feel like themselves becoming water entering the microscopic cell structures and travelling inside to find a way out as reported in the post-lesson interviews and survey (see details later). The dialogic TL/TS flow as exemplified in this episode thus seamlessly connects the students' everyday observable macroscopic world with the scientific modelling of the microscopic

world into a holistic embodied feeling-meaning (Lemke 2018), expanding and transforming their communicative and cultural repertoires.

The descriptions in the above analysis are out of careful consideration, i.e. 'analogy spoken out with Cantonese language features that are frequently present in everyday settings' instead of 'making analogy *in L1 everyday language*', 'simultaneously interanimating' and 'index' instead of 'using multimodalities to create a context', 'immediately latches onto reading aloud an expression with features of written scientific English' instead of 'switching from L1 everyday language to repacking in L2 scientific language'. This is because describing that the analogy *is totally in L1 everyday language* would miss an important nuance of the phenomenon that seems to be seldom discussed in the literature; that is, while the sounding/phonetic features of an utterance may be recognised as more frequently present in everyday settings, the indexical meaning of this utterance in this context is not just everyday but also scientific, or we can say, interanimating (Bakhtin 1981) the everyday with the scientific (see detailed analysis later). It is also in such a fusion that the immediately following vocalising/reading aloud of a scientific English sentence becomes meaningful (i.e. the vocalising of the scientific English is populated with everyday meanings). Therefore, we use 'immediately latches onto reading aloud an expression with features of written scientific English' to delineate this phenomenon, instead of following traditional descriptions like 'switching from L1 everyday language to repacking in L2 scientific language' which implies two bounded languages at play.

Specifically, a fine-grained moment to moment analysis of this episode reveals that the interanimation/connection between the everyday world and the scientific world emerges in and through a concurrent intricate entanglement of all the meaning-making resources available at that moment and space. This phenomenon can be analysed in four layers: First, the embedded analogy of 'losing water' and 'getting water' plays crucial roles in this episode, with very close perceptual and conceptual similarities between *the ground* (the scientific processes of water being pulled up through the cell structures step by step and the interlocking cause–effect relations between the steps) and *the figure* (the daily life experience, logic of 'no water – then get water' and the series of associated actions). In other words, there are similar thematic patterns (Lemke 1990) between the ground and the figure of the analogy that enable the intriguing interanimation between the everyday world and the scientific world continuously.

Second, such an analogy is performed out by Mr. Yeung speaking with several specific language features of Cantonese frequently used in everyday settings, i.e. the use of wordings '無水' (no water), '失水' (losing water), '攞水' (getting water), an increasingly rhythmic, rapid, undulating pitch and intensity of his voice, and gesturing along with speech, which all happen in fine coordination/orchestration (i.e. intonational chunks, bodily movement, and semantic chunks flowing together in synchrony), attuning to the resemblance between the ground and the figure of the analogy and thus strengthening it. In other words, such an effect is afforded by Mr. Yeung using Cantonese everyday style and act of talking/gesturing/vocalising. Since the analogy is based on students' daily life experience, it also necessitates the use of Cantonese for both cognitive and affective purposes, as it is the most familiar language of expression for all the students in the classroom to relate to their daily life experiences.

Third, three kinds of semiotic resources typically indexing scientific meaning and practices are present in this episode, i.e. the drawing of a cell diagram, the scientific terms in English

notated on the cell diagram (i.e. diffusion, evaporation, osmosis) and the drawing of a plant with the water pathway indicated by a curve drawn by the teacher and these resources are well animated by the teacher's analogy, voicing in everyday style Cantonese and hand gesturing over them, forming a synchronised holistic visual, linguistic, gestural and embodied assemblage (Canagarajah 2018) and thus creating a seamless fusion of everyday meaning and scientific meaning. Specifically, Mr. Yeung's voice and speech are animating the visual cell diagram and the notations of scientific terms in English on it, with his voice progressing rhythmically along with his finger tracing along the water pathway indicated by the numbered arrows and pausing shortly at each cell structure passed by (i.e. deictic and iconic gesturing (McNeill 1992) are used here). Towards the end of this episode, as Mr. Yeung speaks and reads aloud the textbook text, he also simultaneously moves his hands back and forth to gesture the action of getting things, resembling cells getting water. He then elucidates the overall phenomenon as 'a series of water chain' and 'transpiration pull' by drawing a curve on the drawing of the plant on the blackboard and talking about water being pulled up in a rhythmically rising intonation, along with waving his hand from bottom up to gesture the overall direction and pathway of water movement from roots to leaf surface (i.e. iconic gesturing is used here).

Lastly, even when towards the end of this episode the scientific concepts are expressed by Mr. Yeung reading aloud the textbook sentence in English in his own voice: 'Water is finally drawn from the xylem vessels, creating transpiration pull', what has been generated by the teacher before this moment is not just a simple annotation/explanation nor unpacking in L1 of this so-called L2 scientific expression. This can be elucidated on two dimensions: From the knowledge construction (thematic pattern) perspective as discussed above regarding Figure 3, the literal meaning of this textbook sentence does not indicate the crucial semantic relation that would help students grasp a complete and logical explanation of the phenomenon (i.e. the interlocking cause–effect relations of the previous three processes leading to this last step), while the teacher's TL/TS whole-body sense-making before this moment enacts this crucial element in a holistic way, particularly through the holistic analogy of 'losing water' and 'getting water'. On another dimension, post-lesson student interviews and survey illuminate that even when the students are writing about the topic in scientific English, his/her mind has been populated with the rich, vivid semiotics experienced in these lessons (see details later). To understand this intriguing effect, it is necessary to take up a multiple timescale perspective (Lemke 2000) to examine what happens preceding this micro-moment. We can then understand how this micro-moment emerges *in and through* all the preceding happenings. That is to say, the meaning of this *so-called L2* scientific expression 'Water is finally drawn from the xylem vessels, creating transpiration pull' is not just literal but infused and populated with multiple *voices* (Bakhtin 1981). Through the TL/TS here-and-now whole-body sense–making, students' everyday experiencing, meanings and semiotics at a longer timescale associated with the 'no water (無水) – then get water (攞水)' sequential/causal patterning in Cantonese (in terms of both semantics and intonation) are confluent with the cultural-historical practices of the scientific community from a longer timescale which are materialised and sedimented in the drawings of the cell diagram and the plant, the series of arrows indicating water movement, the scientific terms of the mechanisms and the scientific expressions (e.g. students' answer 'xylem' in response to teacher's question and the scientific textbook text read aloud by Mr. Yeung's voice in English).

Figure 6. Whole-body sense-making by the teacher.

Tracing all the key actions performed by Mr. Yeung through juxtaposing the snapshots of the three key actions included in the transcript further illuminates what is happening in this episode (see Figure 6). Viewing this series of actions along with the aforementioned speech, intonational chunks and visuals that go together with these actions, we can see that Mr. Yeung is deeply engaged in whole-body sense-making and there is a high similarity among the series of key actions performed by him in this episode: His whole-body sense-making is actually incarnating/embodying the whole complex series of microscopic processes of water being pulled all the way up from inside the plant to the leaf surface and the interlocking cause–effect relations between the sub-processes.

Furthermore, it is observed that the entangling and co-existence of multiple meaning-making resources as exemplified in the above episode is not a temporary phenomenon appearing only in this episode but recurrent throughout the lessons. For example, even after the students had learned and written out an explanation text of transpiration pull in groups for teacher comment, Mr. Yeung continued TL/TS practices such as using the embedded analogy and Cantonese everyday wordings (e.g. '無水' (no water), '失水' (losing water), '攞水' (getting water)) as well as gesturing along with making comments on the students' scientific English texts to help them grasp and express the concepts more cogently (see the key multi-semiotic resources noted in the event map at Sequence 3.2.2 and 3.3.2). This indicates that for the teacher, his TL/TS practices are not meant to just temporarily scaffold for students' scientific English development and then be withdrawn; to the teacher, science exists in an ongoing connection/interanimation between the everyday world and the scientific world.

All the analyses above attempt to highlight that what is happening here in this lesson series is not static, bounded 'code' phenomena that can be delineated in terms of traditionally named languages and registers, but requires new ways of descriptions and conceptualisations. Informed by a fluid, distributed and dynamic process view of human meaning-making (Lemke 2016; Li 2018; Thibault 2011, 2017), we propose starting to describe these phenomena as *translanguaging/trans-semiotising dialogic flows*, or more specifically, they are seamless blending of *different bits of registerial features or tendencies* at every moment (i.e. trans-featuring; see Lin, Wu, and Lemke forthcoming) through intricate and well-coordinated *entanglement* of all the meaning-making resources available at that moment and space, which enables teachers and students to engage in dynamic and dialogic *flows* of collective meaning-making, together forming a holistic multi-voiced gestural, visual, linguistic, and embodied *feeling-meaning* (Lemke 2018) continuously. Importantly, all the plurilingual, multi-semiotic, and multisensory meaning-making resources involved in this process are not just decorative to make the complex concepts/knowledge accessible and lively, but are equally indispensable to forming a holistic feeling-meaning and expanding students' communicative and cultural repertoires continuously, instead of one for (or replacing) the other in a hierarchy. While one may analyse these phenomena post hoc and sense some features of L1 Cantonese everyday register or L2 English scientific register, or even a bit of a contrast between them, ensuing from past cultural experiences and patterning, these features cannot be divided or interlinked in terms of discrete codes in this case: From a traditional structuralist perspective, it is impossible to conceptualise the continuous interanimation (Bakhtin 1981) of meanings between the Cantonese lexical collocations of 'no water (無水) – then get water (攞水)' and the causal explanation text of transpiration pull co-present in these lessons, as these two sets of expressions usually do not correspond in either linguistic meaning or register, yet such a meet-up and interanimation makes good sense under the theoretical lens of *translanguaging/trans-semiotising as flows*, with each other's meaning being expanded. Experiences similar to this have been holistically described in Lemke (2018)'s recent blog regarding the experiences of being in hybrid spaces like church-hotel, church-disco. Similarly, the teaching and learning experiences in this lesson series through translanguaging/trans-semiotising, as exemplified in the above episode, can be described as a complex hybrid experience, yet creating a unitary, expanding feeling-meaning of a new kind. Naming these phenomena in a simple and encompassing way in terms of switching between traditionally named languages and registers would rob away the rich and delicate feeling-meanings engendered from the symbiosis of all the available communicative semiotic features entangled simultaneously.

Impact of the teaching practices on the students

To explore the impact of Mr. Yeung's teaching practices on the students, selective individual interviews were conducted with five students after Day 2 when the main lesson activities were completed and the end-of-lesson survey was administered after the lesson review on Day 3. As the students were oftentimes divided into five groups for group work during the lessons, one volunteer from each group was invited for an individual interview with the first author. In the interviews, students were invited to

freely share whatever they wanted to talk about regarding the lesson series in whatever languages they preferred. The following shows two representative comments[3] from two students, Kelly and Nancy.

> Kelly: At the beginning I felt this topic was quite difficult, as my group thought water just flows by itself from roots to the leaf surface. We did not quite understand how come the process starts from air space and there is a series of complex processes … However, the teacher's explanations help me understand why and the series of complex processes are connected just like in our daily life, 'here no water ('mou2 seoi2'), so get water ('lo2 seoi2')'. At the same time, he also draws and gestures, so the logic and the processes are explained very clearly. We are also taught how to write up these in English accurately. So, when I write about the processes of transpiration pull in English now, I have the drawings and the teacher's step-by-step gesturing vividly in my mind and I just need to follow it to get it right. The impression is very deep!

> Nancy: I think the teaching on transpiration is very good, vivid and clear, especially using drawings and gesturing along with oral explanation. Just like I am a drop of water entering the plant cell structures from the roots and travelling inside to try to find a way out … The cells lose water ('sat1 seoi2'), so they need to get water ('lo2 seoi2'), so water is being pulled, pulled all the way up to the leaf surface. It is a series of cause-effect processes- it is actually the magical power of mother nature!

Based on the key themes that had emerged from the selective individual interviews, a post-lesson survey was constructed and administered to all the students in class after Day 3 to examine whether or to what degree the key themes apply to the whole class and if there are any other comments from the students. The survey results showed that Mr. Yeung's TL/TS teaching practices have a positive impact on all the 18 students ranging from creating an engaging learning experience, helping to tackle the difficult concepts, and mastering writing a precise causal explanation of the topic. For example, all 18 students agreed or strongly agreed to the following statements (original in Chinese; translated in English below):

(1) When I am learning these lessons in class, I feel like a drop of water entering the plant cell structures from the roots and travelling inside to try to find a way out.
(2) I think it is helpful to my learning of this topic that my teacher uses Cantonese to explain difficult concepts while closely following it up with English for key terms, expressions and how to write up the explanation in a precise way.
(3) When I am writing to explain the processes of transpiration pull in English now, I have vividly in my mind the teacher's drawing of the cell diagram, his hand moving along the water pathway and waving up and down, and his series of talking about the processes as 'no water (無水)' -'getting water (攞水)' that help me think through.

It is particularly intriguing that most students indicate that they have transcending experiences like travelling into a different semiotic world inside a plant (i.e. shifting between macroscopic and microscopic views). Moreover, even when they are writing about the topic in scientific English, his/her mind has been populated with the rich, vivid semiotics experienced in the lessons as crucial tools mediating their thinking such as the teacher's drawing of the cell diagram, his hand moving and pausing along the water pathway and waving up

and down, and his series of talking about the processes as 'no water (無水)' -'getting water (攞水)'. These student comments resonate with the first author's feelings as she was observing the lessons and her interpretations of Mr. Yeung's practices as discussed in the analysis above. Importantly, as exemplified by the two students' retelling of transpiration shown above, student learning is more than a simple re-voicing of the teacher's words, but filled with confidence, personal interests and appreciation of the power of nature ensuing from the engaging learning experience provoked by the teacher's rich TL/TS practices. Thus, it can be said that the students have *appropriated* and developed an 'internally persuasive discourse' (Bakhtin 1981). Such an appropriation holds great potential to provoke students' ongoing active inquiry of learning. The fact that the students still reported in the survey deep and vivid impressions of the lesson series one month after the main lesson activities were completed also indicates that the impact of Mr. Yeung's TL/TS teaching practices is sustaining; TL/TS practices are not just a (temporary) scaffold for learning, but continuously transform and expand students' holistic communicative and cultural repertoires.

Conclusion

Informed by a fluid, distributed and dynamic process view of human meaning-making (Lemke 2016; Li 2018; Thibault 2011, 2017) and through a fine-grained analysis of the classroom practices of a biology teacher and his students in Hong Kong, this study challenges the deep-rooted notions of named languages as bounded codes but delineates that human meaning-making is indeed a dynamic, dialogic, heteroglossic process of translanguaging and trans-semiotising (TL/TS) in the flow of knowledge co-making and experiential transformation through intricate and holistic entanglement of multi-verbal /multi-semiotic/multisensory communicative resources. Such practices of TL/TS by the teacher participant in this study are inspired by the key principles of the Multimodalities-Entextualisation Cycle (MEC) (Lin 2010, 2015b, 2019) with his own adaptations as he felt his way along with his students in the flow of knowledge co-making. The teacher's adaptations illustrate that TL/TS can be interwoven throughout different lesson stages from engaging in exploring and making sense of the topic to focusing more on entextualising the experiences and understandings. Importantly, the impact of such practices on students is transformative as evidenced in the post-lesson reports by the students.

Reviewing the teacher participant's TL/TS practices throughout the lesson series as exemplified by the focused episode analysed in this paper, two detailed features seem crucial leading to a positive impact on students:

First, the translanguaging/trans-semiotising and whole-body sense-making practices in this lesson series generate a continuous *flow* of entanglement and interanimation (Bakhtin 1981) between the students' familiar everyday semiotic and cultural patterns (e.g. the daily life experience, logic, and series of embodied actions associated with the Cantonese lexical collocations of 'no water (無水) – then get water (攞水)' as expressed in everyday style Cantonese) and the school-defined semiotic and cultural patterns (e.g. causal explanation of the series of microscopic processes involved in water transport in plants, i.e. transpiration pull). Moreover, the former is not just a (temporary) scaffold for learning the latter, but the two working together in equal status such that students' holistic communicative and cultural repertoires keep expanding continuously. In other words, learning in this lesson

series is a complex hybrid experience, yet creating a unitary, expanding feeling-meaning of a new kind (Lemke 2018) as evidenced in the post-lesson student interviews and survey.

Second, the translanguaging/trans-semiotising and whole-body sense- and meaning-making practices in this lesson series are not just icing sugar to make textbook contents/meanings more accessible to students but were indispensable and crucial in enabling knowledge co-making between the teacher and the students and building up rich thematic patterns and semantic relations constituting the target thematic nexus (Lemke 1990) (e.g. a complete and logically coherent causal explanation of transpiration pull).

With the aforementioned implications, we hope to contribute to moving the theory and practice of translanguaging forward by further theorising translanguaging/trans-semiotising as a fluid, dialogic and dynamic process of human meaning-making and delineating the specific productive features of these pedagogical practices that can serve as principled guidance for practitioners and researchers. As a heuristic curricular tool guiding the pedagogical practices in this study, the MEC (Lin 2010, 2015b, 2019) offers a promising direction for future research and innovation in translanguaging pedagogies in different contexts.

Notes

1. According to the teacher participant, additional lessons after the exam period and in the summer are common at senior secondary levels in Hong Kong due to tight syllabuses and time constraints in regular class time and the time for one lesson in these periods usually lasts longer than a regular lesson of 70 minutes.
2. Another difference between the textbook text and the text co-constructed by Mr. Yeung and the students (Figure 3) is that the former does not include an explanation of what happens outside the air space through the stoma while the latter does (i.e. the first sentence in the latter, which is taught in lesson sequence 3.2.3, see Appendix 1). As Mr. Yeung pointed out in the post-lesson interview, this is, in fact, the ultimate cause of transpiration pull. This is another example illustrating how Mr. Yeung co-constructed with students a more complete understanding of the topic beyond the textbook text.
3. Cantonese words in the original interview excerpts were translated into English, with key Cantonese language features maintained in romantised jyutping, e.g. 'mou2 seoi2 (no water)'.

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No potential conflict of interest was reported by the authors.

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Appendices

Senior Secondary 4 (Grade 10) Biology Class in a Hong Kong secondary school											
Semester 1							Semester 2				
Curriculum	Ch 1	2	3	4	5	6	7	8	9	10 Transpiration (Additional classes after semester exam: Day 1-3)	

Stage I. Exploring and Defining the phenomenon-Transpiration (Day 1)

Day 1: Phases 1.1-1.3

Phases	Sequnces/Activities	Key multisemiotic and communicative resources involved
1.1 Engaging and Hypothesizing whether and where water gets out of a plant	1.1.1 T starts the lesson with daily life experience of watering plants and invites Ss to discuss where water gets into a plant by drawing on bb	T gesturing, daily life experiences (watering plant), T drawing on bb, T & Ss dialoguing in Cantonese
	1.1.2 T invites Ss to discuss another constrasting question if (and where) water gets out of a plan and propose hypotheses on bb drawing	
1.2 Designing experiments and Experimenting on whether anything gets out of a plant (and what it is, from where)	1.2.1 T asks Ss group to design experiments to test their hypotheses by drawing posters	Ss drawings of experimental design, plant leaves, bell jar, tester paper, T & Ss translanguaging dialogues
	1.2.2 T & Ss conduct an experiment together to find out if anything (and what it is) gets out from a plant	
1.3 Defining the phenomenon observed (detailed reading and rewriting)	T & Ss learn about the phenomenon called *transpiration* through detailed reading of textbook and rewriting the definition	textbook page in English, T & Ss translanguaging dialogues, Ss notebooks, bb writing
Thematic pattern co-constructed: Definition of Transpiration Transpiration is the process in which water vapor is lost from the plant surface to the atmosphere.		

Stage II. Investigating the phenomenon and drawing notes and diagrams (Day 2)

Day 1: Phases 2.1-2.3

Phases	Sequnces/Activities	Key multisemiotic and communicative resources involved
2.1 Learning about the specific cell structures from which water gets out	T & Ss read textbook together to find out where specifically water gets out from a plant surface	textbook page in English with visuals, projector, T & Ss translanguaing dialogues, T notes on bb drawing
2.2 Observing how water is transported inside a plant and identifying xylem as the major channel	2.2.1 T distributes vegetable stems and leaves absorbing colored water for Ss to dissect and observe the stems using microscope	T & Ss translanguaing dialogues, vegetable stems and leaves absorbing colored water, knives, microscope, photos, T drawing on bb
	2.2.2 T explains what Ss have observed and identifies xylem as the internal channel of water transport	
2.3 Proposing and discussing the water pathway in drawing and note forms	2.3.1 T invites Ss group to apply knowledge learned so far to propose a complete process how water travels out of a plant by drawing	Ss drawings, T & Ss translanguaing dialogues, *daily life experience (T notes down the water pathway like taking MTR)* , notes in scientific terms in English
	2.3.2 T & Ss make notes of the different proposals on bb in scientific terms in English and discuss which is correct	
Thematic patterns co-constructed: The pathway (cell structures passed by) and mechanism of water transport inside a plant 1. Water travels from xylem to mesophyll cells by osmosis. 2. Water travels from mesophyll cell surface to air space by evaporation. 3. Water travels from air space to the stomata by diffusion.		

Stage III. Engage Ss in Entextualizing the Experiences & Explaining (Day 1-3)

Day 1: Phase 3-Learning to write a causal explanation of transpiration pull (1st draft w drawing)

Sequences	Activities	Key multisemiotic and communicative resources involved
3.1.1 T & Ss co-constructing a complete causal explanation of transpiration pull with reference to textbook	*T & Ss co-construct the causal sequence of the processes of water transport and T explicates a causal explanation of transpiration pull with reference to textbook*	*T & Ss translanguaging dialogues, T drawings and notations on bb, gesturing, daily life experiences (e.g. 無水-攞水), textbook page in English w visuals*
3.1.2 Discussing the significance of transpiration pull	T & Ss discuss the significance and functions of transpiration pull	T & Ss translanguaing dialogues, textbook page in English
3.1.3 Ss Independent Construction (1)- group work	Ss work together by group to write a text to explain transpiration pull, along with drawing showing the water pathway	Ss translanguaging dialogues, Ss group writings in English

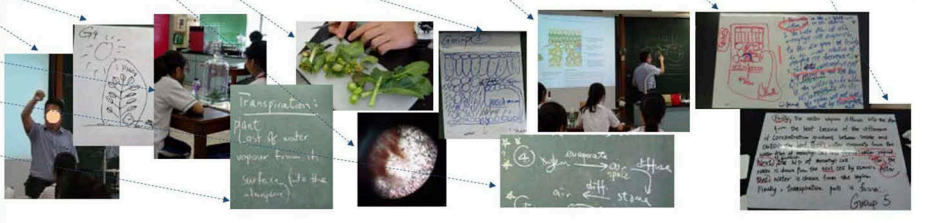
Day 2: Phase 3.2-Commenting on 1st draft and revising (i.e., 2nd draft) (2 days after D1)

Sequences	Activities	Key multisemiotic and communicative resources involved
3.2.1 Reviewing and Highlighting the key points and language features of the explanation	T reviews the phenomenon of transpiration pull with Ss and highlights the key points and language features of the explanation	teacher talk through translanguaging, textbook page in English with visuals
3.2.2 Commenting on Ss group 1st draft sample and all Ss revising (i.e., 2nd draft)	T comments on 1st draft of a sample Ss group writing in class and discusses with Ss how to revise it into a more precise explanation; Ss groups revised in class	Ss group 1st draft sample in English with diagram, T & Ss translanguaging dialogues, daily life experiences (e.g.無水-攞水), sentence pattern
3.2.3 Discussing and writing up the ultimate causes of transpiration pull	T guides Ss to identify four factors as the ultimate causes of transpiration pull and write up a sentence adding to the explanation	daily life experiences, T & Ss translanguaging dialogues, textbook page in English

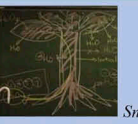
Day 3: Phase 3.3-Review & Learning to write a more precise explanation (3rd and 4th draft without drawing) (1 month after D2, in summer class)

Sequences and Activities	Key multisemiotic and communicative resources involved
3.3.1 T reviewing and modelling writing a more precise explanation in dialogue with Ss	T blackboard drawing, writing in English, along w T & Ss translanguaging dialogues
3.3.2 Ss groups writing 3rd drafts without drawing of water pathway and T commenting on every group writing in class, highlighting the keys to writing a precise and complete causal explanation (key concepts & language features)	Ss group writing in English without diagram, T & Ss translanguaging dialogues, daily life experiences (e.g.無水-攞水)
3.3.3 Ss Independent Construction (2)- Individual work: Ss write up a causal explanation text of transpiration pull withoutdrawing of water pathway by themselves on notbooks	Ss notebooks

Thematic nexus co-constructed by T & Ss: How does transpiration take place? (causal explanation of transpiration pull)
Firstly, due to the difference in concentration gradient of water vapour inside and outside the leaf, water vapour diffuses through the stomata into the atmosphere.
Secondly, water evaporates from the water film of the mesophyll cell to air space which decreases the water potential in the mesophyll cell.
Thirdly, water is drawn from the cell next to it by osmosis.
Afterward, water is drawn from xylem by osmosis which creates the transpiration pull.



Appendix 1. Event Map of the Lesson Series on Transpiration: Trying out CLIL approach with MEC (Lin 2010, 2015b) as a guidance

		Speech	Multimodal Actions and Intonational Texture Observed by the Researcher		
1	T:	呢一連串，呢度↑(P1) 失水，向呢度↑(P2)攞= ((trans: THIS SERIES, HERE↑(1) LOSE WATER ('SAT1 SEOI2'), SO FROM HERE↑(2) GET ('LO2') (WATER)))	As T speaks each line, he simultaneously moves his finger along the arrows of the water pathway previously drawn on the cell diagram on blackboard following the numbering (see Fig. 4), pausing shortly at each cell structure passed by and the corresponding notation of the mechanism each time he speaks 'HERE' in a rising intonation (in Cantonese) (the pauses are indicated in the transcript in numbers, e.g. 'HERE↑(P1)' indicates the first pause; see snapshots on the right column with detailed descriptions tracing these pauses)	From Line 1-4, T speaks in an increasingly rhythmic, rapid and rising tone in Cantonese, resembling the process of water being pulled up through the cell structures one by one	Line 3 (P6): T points to the location of another mesophyll cell along with notation "③osmosis" on the cell diagram Line 2 (P4) & 3 (P5): T points to the location of a mesophyll cell along with notation "③a.osmosis" on the cell diagram Line 1(P2) & 2(P3): T points to the location of air space along with notation "② Evaporation" on the cell diagram Line 1 (P1): T points to the location of stoma along with notation "① Diffusion" on the cell diagram (see Fig. 6) *Snapshots tracing T's actions (Lines 1-4)*
2	T:	=呢度↑(P3)失水，向呢度↑(P4)攞= ((trans: HERE↑(3) LOSE WATER ('SAT1 SEOI2'), SO FROM HERE↑ SO FROM HERE↑(4) GET ('LO2') (WATER)))			
3	T:	=呢度↑(P5)失水↑，又向呢度↑(P6)攞↑= ((trans: HERE↑(5) LOSE WATER ('SAT1 SEOI2'), SO AGAIN FROM HERE↑(6) GET ('LO2') (WATER)↑))			
4	T:	=咁最終喺邊度↑攞水↑啊？ ((trans: NOW FINALLY FROM WHERE↑ WILL IT GET WATER↑ ('LO2 SEOI2')?))	As T speaks 'FROM WHERE↑ WILL IT GET WATER↑' ('lo2 seoi2') in a rising intonation (in Cantonese), he simultaneously moves his hand from outside to inside to gesture the action of getting things, resembling cells getting water.		
5	Ss:	◌Xylem◌.			
6	T:	從 xylem 度攞。所以我哋望上上面 ((trans: GET ('LO2') IT FROM xylem. SO WE LOOK UP HERE)), we say "Water is finally drawn from the xylem vessels, creating transpiration pull".	As T speaks 'LOOK UP HERE' (in Cantonese), he points up to the textbook line projected on the screen and then reads the textbook line in English (see snapshot on the right)		 *Snapshot (Line 6)*
7	T:	咁就形成咗一連串嘅水鏈= ((trans: SO IT FORMS A SERIES OF WATER CHAIN))	As T speaks 'A SERIES OF WATER CHAIN' (in Cantonese), he draws a curve on the plant previously drawn on the other side of the blackboard, starting from the roots, the stem to the leaf surface, ending with an arrow pointing outside the leaf, indicating the pathway of water movement and direction in the plant (see snapshot on the right)		 *Snapshot (Line 7)*
8	T:	=呢條鏈有個專有名詞去形容佢，就係哩個蒸騰牽引力，transpiration pull. 即係話, 依家棵植物，因為上面失水，所以一路扯, 扯↑, 扯↑，由根一路扯水↑上去。((trans: THIS CHAIN HAS A SPECIFIC TERM TO DESCRIBE IT, THAT IS, 'ZING1 TANG4 HIN1 JAN5 LIK6', transpiration pull. THAT IS TO SAY, THE PLANT, BECAUSE ON THE SURFACE WATER IS LOST, SO ALL THE WAY (WATER IS BEING) PULLLED, PULLLED↑, PULLLED↑, FROM THE ROOTS ALL THE WAY WATER IS BEING PULLED UP↑.))	As T speaks 'transpiration pull' in English, he points to the textbook line 'creating transpiration pull' projected on the screen; Then he utters 'PULLLED, PULLLED↑, PULLLED↑, FROM THE ROOTS ALL THE WAY WATER IS BEING PULLED UP↑' in a rising rhythmic intonation (in Cantonese) and simultaneously waves his hand from bottom up to gesture the overall direction and pathway of water movement from roots to leaf surface (see snapshot on the right)		 *Snapshot (Line 8)*

Appendix 2. Multimodal transcript of the focused episode.

Appendix 3. Transcription conventions.

Transcription conventions

T	Teacher
S/Ss	Unidentified student/several or all students simultaneously
↑	Rising intonation
呢度失水… ((trans: HERE LOSE WATER ('SAT1 SEOI2')…))	Sentences with Cantonese utterances are followed by an English translation in double parentheses (English translations of Cantonese words are in capital letters, with key Cantonese language features/tones annotated in romantized jyutping in single parenthesis, e.g. 'LOSE WATER ('SAT1 SEOI2')'. English words originally blended into the phrase/sentence, if any, are maintained in the translation in lowercase letters.
呢度 (P1)	Single-line underline of speech indicates there is multimodal action or feature accompanying the utterance and researcher's descriptions of multimodal action or feature will be provided in the right columns of the transcript
呢度 (P1)	Numbered notation beginning with 'P' indicates short pause of action accompanying the utterance and researcher's descriptions will be provided in the right columns of the transcript
Water is finally…	Double-line underline indicates the utterance is a reading aloud of a written source
= =	Turn continues below, at the next identical symbol
° °	low voice