How 'language-aware' are lesson studies in an East Asian high school context?

Abstract

Educators worldwide have been attracted by lesson study for its teaching and learning enhancement potential. However, some believe it takes for granted language, out of which all teaching and subject matter are made. Employing a functional linguistics lens in an analysis of two second language science lesson studies, called 'learning' studies in Hong Kong, the paper evaluates the extent of a language-aware perspective in the studies. The data are recordings of the most polished lessons in the lesson study cycles, with planning, teaching and testing materials from post-study presentations. Minimal evidence of a language-aware perspective was found. That is, the academic 'content' was de-contextualized in that lessons focused on propositional knowledge rather than its academic cultural use in explaining, reporting or discussing science; and attention to the cognitive-academic language (CAL) construing the science was negligible. The teachers' CAL seemed unplanned and students' CAL development was largely ignored. Some recommendations are made and significant implications of the findings are addressed.

1.0 Introduction

Japanese lesson study (Jugyou Kenkyu) has aroused international interest (Matoba et al 2006) for its assumed role in Japan's success in international tests (Stigler and Hiebert 1999). Lesson study's features are a collaborative teaching culture, a focus on subject knowledge and a research orientation to refining a single lesson (Stigler and Stevenson 1991). The vast majority of studies are in mathematics and science. The rather 'young' lesson study literature deals with issues such as 'lesson study's role in pre-service and in-service teacher education for the improvement of subject teaching and learning' (e.g. Lewis, Perry and Hurd 2009; Parks 2008; Elliott and Yu 2008; Lee 2008; Siu 2008; Kolenda, 2007; Fernandez, Cannon, and Chokshi 2003); 'teacher and student subject understandings and teaching methodology' (e.g. Runesson & Mok 2007); 'teacher collaboration' (e.g. Parks 2008; Adamson & Walker (in press)) and 'lesson study management and sustainability' (e.g. White and Lim 2008; Perry and Lewis 2009; Elliott 2009). The 'practitioner-oriented' lesson study literature mainly deals with 'subject-matter (mis)conceptions and student learning outcomes' (e.g. Lo, Pong and Chik 2005; Tran 2007); and lesson study implementation (e.g. Ulep 2007; Paulsen 2007). However, nowhere in this literature that I am aware of, apart from my own contribution, is there explicit, theorized attention to linguistic literature, or the essential role language plays in the learning study process or outcomes, in the same way that, for instance, pedagogical literature or learning theory are made explicit, for example in analytical

frameworks and discussions. This is true even for language learning studies, e.g. Siu (2008) and Lee (2008), in the HK context, where socio-cultural aspects of *learning* are foregrounded such as 'learner perspectives' and 'teacher autonomy'. While the words '*pedagogy', 'teachers' content knowledge' 'practical knowledge', 'collegiality', 'professional development', 'practice-based learning'*, figure prominently in lesson study, the words 'language', 'linguistic theory', 'subject discourse', 'text', 'construe' either do not feature at all, or do not feature anywhere near as frequently as might be expected given that *all* of the italicized are made of language, and that language is central to all subject teaching and learning (section 3.0). In these senses a language-aware perspective is invisible in lesson study literature, but this gap has seemingly gone unnoticed. This invisibility, or the apparent taking-for-granted of subject content *as* language as well as participants' knowledge *about* language *as* subject content (Love 2009) was the impetus for this study, in an attempt to break new theoretical ground in lesson studies, as well as address social justice in the HK context (see below, and section 3.0). I thus examined HK learning study data in one frequently occurring subject, science, to obtain empirical evidence of the extent of language-awareness in HK's lesson studies.

In view of the argument for more linguistic theorization, it is worth noting three ways in which HK learning study differs from the original Japanese lesson study. These differences have tended to produce a more theorized orientation in the HK context. First, the leader of every study is not a school teacher, but an academic, a teacher educator. Second, learning study embraces an explicit theory called Variation Theory (Marton and Booth 1997), the basic vocabulary of which is in **bold** in the text below. Variation theory has arguably (Pang and Marton 2003) enriched lesson study, though whether it is a psychological or a pedagogical theory is open to debate (Elliott, 2009). The theory has nevertheless been incorporated into pre-service and in-service professional development at the author's institution. Third, the funding for and ethos of HK Learning Study requires participants' public presentations at the HEI, data from which is used in this paper (section 4.0). The potential for theoretical critique arising from such presentations, exemplified in this paper, is so far untapped in the literature.

In the HK context, Lo, Pong, and Chik (2005) report over two hundred HK learning studies informed by Variation Theory, and make strong claims for successful learning enhancement among the 'community of learners'. This is generally in line with other literature, cited above, and the public presentation claims of the studies forming this

paper's data. However, if language-awareness was found lacking here, the claims for success in this context, and by possible extension elsewhere, might be too strong, because of the centrality of language in all learning. This is the important matter explored here. The exploration is by re-examination of learning study data from a linguistic perspective missing from the lesson study literature. Therefore, the question guiding this investigation is informed not by lesson study literature but by linguistics literature: '***to what extent do two junior secondary (high school) science Learning Studies demonstrate language-awareness?'*** Criterial questions are provided in section 4.1 fleshing out what is meant by 'language awareness' in terms of the applied linguistic theory summarized in section 3.5.

The language theory, which requires a little space for non-specialists to appreciate the significance of the criteria and to follow the findings, is that of Systemic Functional Linguistics (SFL). SFL is employed for three reasons. First, SFL is the school of linguistics which makes the strongest claims for the role of language in education as a matter of social justice (equitable access to socially valued discourse), and for intellectual development as language development (e.g. Christie and Derewianka 2008; Halliday 2007; Butler 2003; Halliday and Matthiessen 1999). Second, SFL has invested most scholarly effort into describing the language of schooling driven by social justice concerns (e.g. history: Coffin 1997, Derewianka 2007; mathematics: Veel 1999, O'Halloran 2005; science: Christie and Martin 1997; Halliday 2004; English, history and natural sciences: Schleppegrell 2004; Christie and Derewianka 2008). Third, SFL is widely used for Chinese text analysis (Zhang et al 2005; Shum 2006) which could naturally be used for the Chinese-medium learning studies, by far the more prevalent in HK.

2.0 Theoretical foundations and practices of HK learning study

Variation Theory (Marton and Booth 1997) makes explicit the importance of viewing an **object of learning** from varied perspectives, rather than in abstracted isolation. 'Object of learning' means 'what is being learnt'. For optimal learning to occur, teachers use the principle of variation in pedagogy so that students are helped to see the object of learning from different perspectives, or to discern **critical features** in the object of learning which must happen for learning to occur. Discernment is achieved when students notice four basic **patterns of variation**: contrast - what the object of learning (say, X) is and what it is *not*; generalization - what X is in context A and what it is in context B; separation - what X has in common with other values on a central varying dimension; fusion - what X

is when related elements are simultaneously varying (Lo and Pong 2005, 21-22). In HK Learning Study a group of around six teachers of a subject collaborate in planning '**research lessons**' on an object of learning. First, they identify the critical features of the object of learning, or ways in which it can vary. Next, they design a **pre-teaching-test** to reveal variation in students' understandings of the identified critical features. The test outcomes are examined for common problems; an entry point for the teaching is identified; and a draft lesson plan is collaboratively prepared, incorporating pedagogy for discernment of variation in the object of learning. As each group member teaches the planned lesson to her own class the lesson is 'researched', typically through lesson observation and student interviews. After the final research lesson, implementing the **most polished plan**, the pre-test is again administered, along with final interviews of three students of differing abilities, as **post-tests** of learning. Section 3 below lays the groundwork for the language perspective informing the data analysis.

3.0 Language as central to education and intellectual development

Systemic functional linguistics (SFL) sees language as a **semiotic** (meaning) system**, and semogenic** (meaning-making) **system.** Semiotic systems comprise and are more complex than all other systems in human experience – the physical, biological, and social (see Kilpert 2003 for details)**.** As a semogenic system, language **construes** (i.e. constructs in a non-material sense) all human experience and enacts all human social processes. It is not simply a set of prescriptive rules, as in traditional grammar, to be mapped onto pre-existing 'content' for production in sets of sentences. Language is at the centre of education, because 'learning anything at all means turning it into language' (Halliday 2007, 353). There is no subject teaching without language, because discourse is what turns our experience into knowledge, and knowledge is *made of* language. The target of all schooling, then, amounts to the systematic mastery of *language use* in an increasing range of experiences or socio-cultural, academic contexts ('**genres**') in which students are participating and in which they are likely to or aspire to participate as they grow older. Genre, defined as purposeful language use, is further addressed in 3.1.

Since language is at the centre of education, language development *is* intellectual development. Briefly put, the SFL view of the intellectual development task of schooling is that students move from 'congruent' everyday language to increasingly less congruent language (Halliday 1993). Failure, in the SFL view, is when students do not make this move. This is not incompatible with the learning study view of failure as 'limited discernment' (Lo, Pong and Chik 2005, 21) because discernment must always be

construed on the social plane and demonstrated through language (e.g. in interview or written text). The 'move' means that an individual's intellect *as manifested in language* develops from the 'basic interpersonal communication skills' (BICS) of commonsense everyday life to 'uncommon' sense (Bernstein 1975) Cognitive Academic Language (CAL) (Cummins 1992) of senior secondary and tertiary education and all higher-order thought processing. CAL is no-one's mother tongue, and must be explicitly taught (Christie and Derewianka 2008, 214), particularly where students have no opportunity or capacity to intuit the highly socially valued workings of CAL.

One of the most important SFL insights into CAL as intellectual development concerns '**grammatical metaphor**'. This means the CAL grammar turns one word class or structure into another, thus altering the context-embedded **congruent grammar** of childhood language. For example, 'happenings' and 'actions' are, in CAL, no longer (congruently) verbs, but (**non-congruently**) nouns, such as when '*used*' becomes 'in *use*'. Happenings also become (non-congruently) adjectives ('the price *is rising*' becomes '*rising* prices'); and qualities are no longer adjectives, but nouns ('*illegal* activities' becomes '*illegality*'). In CAL, as opposed to non-CAL everyday language, experience is 're-construed' from being verb or action-based to noun or 'thing'-based. This re-construal, or nominalization, is useful in academic cultures because, unlike verb groups, noun groups are far more expandable, and denser, gradable meanings can be compacted within them. A simple science-related example is: 'X <u>can</u> project light' becomes 'X's partially demonstrated and exploitable <u>ability</u> to project light'. Another central CAL feature manifesting and enabling intellectual development is the 'stretched' grammar of verbal processes (e.g. tell) or relational processes (e.g. show). This 'stretching' of the grammar construes lower order meanings on which is built a higher order meaning, e.g. 'The *table* (inanimate) '*tells'* us (lower order) the risk of early death increases as smoking increases (higher order)'.

3.1 Genre

As recognized by Bunch et al. (2010, 185), two of whom are non-linguists, genre (section 3.0) is a linguistic concept that 'can be helpful in understanding the grammatical, lexical and rhetorical demands associated with […] different kinds of texts' in subject learning. Text is defined as 'an instance of a genre'. Genres, in SFL, represent all the purposes human cultures (including academic cultures) might accomplish through language, e.g. narrating, explaining, describing, discussing, or reporting. Every conventional spoken or written academic meaning *is* genre. The conventionality means that generic texts are

quite predictable and therefore teachable. A text producer, a speaker or writer, chooses from the grammar system's options based on understanding of generic contextual configurations. That is, each of the variables in any context tends to be associated with particular language choices forming the text. So, the topic and the nature of interactants' relationships, and the relatively spoken or written nature of the context will resonate with different elements of what is called the '**text architecture'**.

3.2 The architecture of any text in any language in any school subject

Table 1 (Appendix) is a basic illustration of what is meant by a text's architecture - the connection of scientific meaning and language. It is not necessary that all readers fully grasp the technical aspects of the analysis since it is clear that 'the technical nature of some [linguistic analyses] has been off-putting to many non-linguists' (Bunch et al. 2010, 186). What is necessary to understand is that such analyses can apply to any text in any language in any school subject. There is ample evidence of learning advantages and increased access to socially valued academic discourse when the analysis is taught explicitly (Martin, 2009; Teruya 2009; Zhang et al 2005; Polias 2005). The analysis reveals **critical features of any text,** or how texts vary. This means students can observe how meaning is made in one sample text. This enables them to begin to produce similar texts with a similar grammatical arrangement, and to understand that different genres will have a different 'grammar', in terms of structure and specific language features, which are shared and expected by members of a particular academic culture.

3.3 Explaining the architecture

As exemplified in Table 1 (Appendix), the different meanings brought together in the grammar of any text in any subject in any language are referred to as **ideational, interpersonal and textual.** They work together to make meaning in the way that different instruments of an orchestra simultaneously make music. These so-called meta-functions provide a way of talking about language in use, and can therefore be very useful in teaching, because of the repetition, predictability and consequent teachability mentioned. For example, two texts, an 'experimental procedure' and a 'research report' clearly use language in quite predictable but different ways in terms of staging (order of meanings across the text); topic or ideational meaning (construed by noun groups and verb groups); interactants' interrelationships or interpersonal meaning (construed by, for example, grammatical mood, evaluative wording, and the verb tense system locating events in time relative to the speaker/writer's 'here-and-now'); and textual meaning, or language for forming coherent and cohesive texts e.g. by a speaker's selection of first

words in a clause, or semantically-related lexis *across* a text (e.g. seed, grow, soil, air, warmth, moisture, shoot).

3.4 Conceptual and pedagogical variation as linguistic variation

All teaching, hence all subject teaching and subject-compatible first and/or second language teaching, involves pedagogical and conceptual variation, according to Variation Theory (section 2.0). Clearly, both forms of variation materialize in language. Linguistically, 'variation' is defined as 'speakers and writers making linguistic *choices* ideationally, interpersonally and textually in unfolding speech and writing'. Language-aware subject teaching and all language teaching involves teachers showing students how wording choice P, and choice configuration Q make a different and differently socially valued meaning from wording choice X, and choice configuration Y. Pedagogical variation happens when teachers choose from the variety of potential wordings realizing the pedagogical 'regulative' register (Christie, 1999), such as '*I need you to notice …*' or '*please observe ….*'. These wording choices then project the equally variable wording realizing the variation in the concepts or subject matter (the instructional register) '*…that if the light goes to different parts of the retina, the image is clear*'. As speech, this is a rehearsal for written CAL (Love 2009).

3.5 Summary: language-awareness indicators

The language perspective above means that a fully language-aware learning study would exhibit the following. First, the content aim or object of learning and/or the task assessing that learning would not simply be '*knowing that* X'. It would be contextualized as '**genre**': *demonstrating knowing that X by using knowledge of X to achieve a social function such as reporting or explaining X*. Second, the critical features of the object of learning would explicitly address (the variation in) **the CAL in which they are construed**, and there would be evidence of planning the wording of the teacher's CAL talk because without the teachers' language choices construing the instructional register (or 'content'), there would be no 'content' and **without explicit teaching of the CAL, students may not learn it, as it is so context-reduced it is no-one's mother tongue**. These indicators are further specified in the analytical questions in Table II below.

4.0 Data and participants

The data were video-recordings of two complete research lessons, each around 54 minutes, and two sets of presentation slides. The lessons were the 'most polished' lessons of each study, the final lesson. The slides were compiled by each learning study team –

leading academic, co-ordinator, and teachers (see section 1.0). Several data types were scanned onto the slides. The scanned data are the normal products and artifacts of learning study, generated because processes (e.g. lesson and test planning) and products (e.g. lesson plans, test output, student class-work, teacher reflections) of each officially funded study must be orally presented by the participating teachers in a two-hour public forum most often at the author's HEI. All the open seminars at which the slides in this study were presented involved the professorial leader of HK Learning Study, other learning study academics, HEI academics from the study's subject area, all the study's teachers, and often the school principal and/or members of the education ministry and/or members of educational funding bodies. The video-recording of each seminar was later made available on a web-site accessible to registered HK teachers. Each presentation was multi-modal, with hyperlinks among written slides and audio-visual data such as video-recorded excerpts of lessons, teachers' meetings and student interviews.

The data used here relate to two second language (English) science learning studies carried out in a total of 8 intact classes (2 studies x 4 lesson-cycles) at secondary 2 (S2) level. S2 data was chosen because they are typical of most HK junior secondary school learning studies, and at age 13-14 students are cognitively ready for CAL exposure (Christie and Derewianka, 2008) which is an important aspect of language awareness in this context (section 3.0). The data relating to each research sub-question is listed in Table II below. Member checking of findings (Morse et al 2002) was also carried out by circulation of a version of this paper, and its oral presentation to the HEI learning studies' academic leaders and co-ordinators. One leader stated that while he, as a semi-retired academic, could not 'undo or re-do' his learning study work, he could now understand the significance of a language-aware perspective (December, 2009).

4.1 Data Analysis

Table II further specifies the criteria for language-awareness derived from section 3.4:
[Table II]

5.0 Findings and discussion

(Figures II & III)

5.1 Genre contextualization

Figures II and III show that the objects of learning were abstract scientific phenomena construing scientific CAL. The Figures also show striking similarities in lesson stages: teacher-led introduction, observations of 'experiments' for discernment of variation in the object of learning, and some form of written post-observation activity. However, there is no explicit contextualization of the object of learning as a text, an instance of a genre, in the critical features. That is, there is no wording such as 'a causal explanation of [eye defects/aluminium use in cooking vessels], a description of [two eye defects], or a summary report of an experiment on [metal reactivity].'

Nevertheless, lesson data of both studies indicates potential for genre contextualization. In Study 1, the experimental results were reported in a Table where one axis was the acids (concentrate and dilute), and the other was the metals. The teachers' context-embedded, non-generic summary report was: '*OK now, it seems that all of our data quite agree [pointing to 'copper'] this one with no reaction, [pointing to 'iron', 'magnesium' and 'zinc'] and this one with reaction, and this one with and this one with'* (33.05). The teaching stopped short of using the Table to model or elicit a short, simple CAL-compatible, oral 'descriptive report', e.g. '*The Table shows that copper reacted with none of the concentrated or dilute acids, while iron, magnesium and zinc reacted with both concentrated and dilute acids'*. This would have lead in a more scientific way to discernment of the planned critical feature, 'some acids react with metals, while some do not', which was clearly the teacher's concern (37.00). Study 2 lesson offered similar contextualization potential. The teaching also helped students engage with a useful Table (Table III) synthesizing their observations, but did not fully exploit the Table as an organizer of an 'explanation' exemplified in section 5.2. The post-observation stage also provided opportunity for students to explain the causes of eye defects in writing, but again did not contextualize the task as an 'explanation' (section 5.2 and Figure IV).

Despite the lack of genre exposure in the Study 2 teaching, students were required to write short explanatory texts in the post-test. For example, '*A boy, Bill, is sitting for an examination in the school hall. After looking at the clock, Bill turns to his watch to check the time. Describe the change in his eyes when he tries to look at his watch'*. In Study 1, output was more consistent with the teaching, consisting of ticks on multiple choice items such as '*Metal A is put into two test tubes containing acid Q and diluted acid Q separately (diagram supplied). Which of the following is/are possible answer(s)? (a) Metal A reacts faster in test tube 1. (b) More bubbles come out in test tube 2. (c) There is*

no difference. (d) We cannot determine the result.'

It is interesting that study 2 students were assessed by a cohesive 'text' without any oral rehearsal or supported written practice in the lesson itself. It seems the planning team had some understanding that a text is richer 'discernment' than discourse fragments such as discrete sentences or words. The non-textual output of Study 1, while being convenient to assess, might be evidence of limited language-awareness. This is because it does not provide students with opportunities for independent reconstruction in the form of experientially accurate, interpersonally appropriate, cohesive spoken and/or written text materializing scientific discernment. While limited output is possibly acceptable in primary school, site of the Lo et al, (2005) learning studies, increasing CAL demands could put pressure on immature linguistic/intellectual resources as students move up secondary and tertiary education. Most secondary school students not receiving explicitly contextualized understandings probably would not adequately develop a socially-valued science genre repertoire. Such a repertoire, it is argued, defines intellectual development (section 3.0 and c.f. Shum 2006 arguing for genre teaching in Chinese). The role of the language specialist could be helpful here in assisting the subject specialist to identify CAL genres towards which a learning study might progress. S/he could then assist in an 'adequate' text architecture analysis (Appendix), and subsequently how the grammatical configurations across the target genre make the scientific meanings.

5.2 Explicit language-focus in student CAL development and in planning teacher talk

It has been established above that there was no CAL text focus in the lessons, so obviously there was no focus on CAL grammar beyond the clause, across text (Appendix). There was also no explicit sub-textual language focus. In neither study did the critical features include wording such as 'the above (critical features) are construed by wording *similar to* [Figure 1], with text architecture *exhibiting language choices and patterns* as in [Table 1]. Also, in neither study's lesson plan data were there steps where the teacher focused students' attention on the wording choices of the critical features. This is despite the fact that in both studies, several critical features are nominalized CAL e.g. 'the length of the eyeball' instead of 'how long the eyeball is'; 'the degree of convergence of the convex lens in the eye' instead of 'how much the convex lens in the eye converges'; 'acid['s] concentration' instead of 'how strong the acid is' .

For example, in the Study 2 'eye defects' lesson Table III was displayed prominently on the blackboard. However, the teacher did not seem to see the Table as CAL wording. Instead, he seemed to see the Table as a memory aid, telling students '*the Table will help to remember some of the things'* (22.40) and '*now pay attention to the Table and the main points. Make sure you remember'* (38.01).

(Table III)

Table III could clearly support the following CAL explanation, which displays typical context reduction and the nominalization of the critical features from the lesson plan data: *A normal eye sees clearly because the image forms on the retina, the lens has normal thickness and the eyeball has normal length. A shortsighted eye cannot clearly see distant objects because the image forms in front of the retina, the lens is too thick and the eyeball is too long. Short-sightnedness is corrected by diverging/divergence of light rays through a concave lens. A long-sighted eye cannot see near objects clearly because the image is formed behind the retina, the lens is too thin and the eyeball is to short. Long-sightnedness is corrected by converging/convergence of light rays through a convex lens.* In contrast, the teacher's wording did not progress beyond the following which is more context-embedded, verb-bound, and 'interrupted' with regulative wording such as questions and '*remember*'. (Capitals indicate louder wording). '*For short-sightedness, a person suffering from short-sightedness he cannot see distant objects clearly. The image focus in front of the retina so it is blur and one of the reason is because len[s] is too thick, (spoken more quietly) so remember where is the image, thickness of the lens AND also part of the problem comes from the length of the eyeball (pointing to Table) BECAUSE sometimes some person some suffering from the eye..the short-sightedness because the eyeball is too long so it will have the same result that the image will be in front of the retina AND how to correct? We want to BEND the light rays more, so in another words we DIVERGE, we want to DIVERGE the light rays, yes? So we want to use which type of lens to diverge the light rays? As you all know, concave lens'* (36.50) There was a similar partial re-contextualizing of the Table at 47.23. On neither occasion were there chances for students to practice saying or writing the Table in cohesive CAL wording.

Similarly, the Study 2 post-observation written task was presented in point form as discrete 'facts'(Figure IV), even though the answers to 'the causes of X can be…' grammatically require the nominalization explicitly stated in the critical features (Figure III). The causes were instead orally elicited and modeled as (often flawed) clauses,

presumably resulting in the (often flawed) answers shown in italics in Figure IV. For example, the teacher prompted '*The first reason for short-sightedness is because the lens is too…too…too…anyone?'* (51.27) and eventually '*because the lens is too thick so the image focus in front of the retina. Another cause is because the eyeball is too big*', and then '*The reason why a person with a longsighted eye because his lens is too thin so it focus the image behind the retina. Another reason is because the eyeball is too short*' (53.56). The teacher did not display an accurate CAL text with the planned wording of the critical features, such as '*The causes of short-sightedness are the degree of convergence of the convex lens in the eye and the length of the eyeball'*

(Figure IV)

In Study 1 too, there was potential for developing understanding that 'some acids react with all metals' into a CAL causal explanation of the problem framing the entire lesson 'Can I cook lemon coke in an aluminium pan'? Instead, there was apparently no scripting of this episode of teacher talk which materialized, as in Study 2, as a seemingly unplanned, considerably context-embedded, minimally CAL-compatible teacher monologue without use of the pre-planned CAL-compatible critical features and without any student focus directed towards language: '*This is some secret about aluminium. Aluminium can react with acid, but at the beginning you found that it is quite slow because that it has reaction with other things. It has reactions with the oxygen in the air. You know that anytime I cut the metal it can react with oxygen because everywhere is air. So […] when I freshly cut it, when it touch with oxygen, when it react with oxygen, it form, we say that it form an oxide, or with the other way we say that it form a protective layer, it cover it (hand covering fist), so [..] when we put in acid it seems that no reaction, or it seems that the reaction is very slow, but later when the acid gets into the aluminium the reactions come out then….(directs students to consult textbook …reads?) It has reactions, but because it has a protective layer this layer is resistant to the acid*' (49.20).

Explicit teaching of language was observed only fleetingly at word level. For example, '*The image right here focus onto the retina. The most important part is the preposition 'onto', alright? And the other thing is the image is 'sharp', and the opposite is 'not sharp' or you may say 'blur.' [..]Got it*?' (11.00, Study 2) A similarly momentary language focus occurred in Study 1, where rather idiosyncratic pronunciation of 'copper' and 'magnesium' was modeled for students' repetition (19.39). Regarding planning data, in

Study 2, there were some seeds of attention to the wording of student responses (Figure III), though once again the concern for appropriate CAL was clearly absent.

The evident lack of attention to planning significant episodes of teacher CAL contrasts with Japanese lesson study's apparently intuitive insistence on carefully scripted teacher wording (Fernandez et al 2003, 179 and 181). Significantly, the cited study and all Japanese lesson studies are in *first* language. The lack of attention to HK students' *second-language* CAL development seems a logical consequence of the lack of awareness of teachers' *second-language* CAL. An implication of this is that HK learning studies might need to account better for the fact that the conceptual variations in the object of learning and the pedagogical patterns of variation which project the conceptual variations are both construed in CAL wording. Students need to notice in the pedagogical discourse, the CAL wording construing the conceptual variation, the instructional register, and the regulative register projecting the instructional. A simple example, at sentence level, follows. In study 1, the planned wording construing the 'contrast' pattern of variation in the concept, guided by the Table of Variation (Table IV), was '*some metals react with acids, while some do not*'. Scripted teacher wording construing the regulative register might have been '*So it is important that you noticed, in the experiments,….. .* As well as noticing this wording, most students would also need to hear a contextually appropriate variation of wording such as: '*Let's say together: 'some metals react with acids, while some do not'. Good. Here, 'while' and 'do not' are important words for talking and writing science. Look. 'While' creates the [adversative logical] relationship between the two [academic] meanings 'some metals react with acids' 'some metals do not (react with acids)'. 'Do not react' is the negative contrast of positive '(do) react*' '.

Again, a language specialist collaborating with the science learning study team could work from a text architecture analysis of the selected scientific genre. The language specialist could help the science specialists plan explicit linkage of the critical features of the genre-contextualized scientific object of learning with the appropriate scientific language. That is, the language construing both the critical features and the teaching episodes materializing the critical features.

6.0 Conclusion

The findings of low levels of language-awareness indicate that that much work is to be done in teaching cultures, firstly to address the artificial, organizational boundaries in

schools separating teaching of 'content' and 'language' and secondly to enable all teachers to accept responsibility for and feel competent in being language-aware teachers, possibly interrogating current traditions in language teaching, which might be seen to convince science teachers they are incapable of teaching the language of science. To achieve such subject language-awareness, the paper values the fundamentally collaborative orientation in global lesson/learning study, recommending and demonstrating mutually beneficial theoretical and practical interaction between science and language specialists.

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Figure 1 (see Appendix)

Figure II: Learning Study 1 data summary

Topic: Acids and Alkalis

Object of learning: Reaction of acids on metals (slides 6-21 of 47)

Lesson sketch from recording: Teacher (T) raises a problem: can I cook lemon coke (a local favourite mix of Coca-cola and lemon juice) in an aluminium saucepan? T asks students (ss) to write 'yes' or 'no' with justification. Teacher writes 4 hypotheses on blackboard: *All metals will react with all acids; All metals will react with some acids; Some metals will react with all acids; Some metals will react with some acids*. T-ss match 'yes' and 'no' responses to an appropriate hypothesis. Student groups observe reactions of different metals with acids of different concentrations, two groups working with each acid. Students supply ticks or crosses to a Table of results on board indicating presence or absence of reactivity. T summarizes the results: 'some metals will react with all acids'. T re-addresses the initial problem. T-ss discuss testing the reactivity of aluminium. T sets up one test and circulates with the test among ss who observe aluminium's slow reactivity while completing a written activity (unavailable). T explains 'the secret about aluminium' (its protective layer) and elicits the answer 'no, in the long term' to the initial question (51.31).

Critical knowledge features (CF) (slide 21)**:**

1.Some metals react with acids while some do not;

2.When a metal reacts with an acid, it is independent of the acid's concentration;

3.When a metal reacts with an acid, it also reacts with all kinds of acids of different concentrations

4.The reaction taking place depends on the metal, not the type/ strength /concentration of the acid.

Lesson plan (slides 23, 26) indicates no step where teacher focuses students' attention on wording choices. A Table of (conceptual) Variation guiding the planning is provided (slide 23), without script of teacher talk materializing the variation focus. Test output is multiple choice responses (slides 27-30 & 37).

Figure III: Learning Study 2 data summary

Topic: Eye defects

Object of learning: Optical view of the formation of short-sightedness and long-sightedness and their correction (slides 6-16 of 45)

Lesson sketch from recording: T reviews eye structure and the 'pathway of light' into the eye. T poses the problem of eye defects, defining defect as 'the defect is somewhere happened when the light enter the eye' (7.00). T describes, ss observe a set-up demonstrating normal sight, short-sightedness and long-sightedness. T uses a Table on the blackboard to elicit and summarize students' discernment of variation between the normal and defective eye in image focus and corrective lens. Selected ss manipulate lenses to observe which lenses provide the solutions. T uses blackboard diagrams to help ss discern variation in eyeball length. Ss complete a written task on the cause of eye defects (54.00).

Critical knowledge features (CF) (Slide 16)**:**

1. *Sharp images can only be formed when focused on the retina;*

2. The causes of short-sightedness and long-sightedness are: the degree of convergence of the convex lens in the eye; and the length of the eyeball

3. The divergent and convergent nature of the concave and convex lenses determines the use of appropriate lenses for the correction of the above eye defects.

Lesson plan (slides 18-22, 24-27) indicates no step where teacher focuses students' attention on wording choices. A Table of (conceptual) Variation guiding the planning is provided (slides 18,19), without script of *teacher* talk materializing the variation focus. There is scripted, anticipated *student* talk construing discernment, e.g. '*The cause of short-sightedness is too converge and so sharp image can't be formed on the retina'* [sic](slide 18). Test output is: written interpretation of two ray diagrams, e.g. to answer 'yes' or 'no' to 'Can Mary see the distant object clearly?'; and four explanatory texts, up to 20 words each (slides 31-42).

Figure IV: Study 4 teaching materials

Short-sightedness can be caused by:

1. *[because] the lens is too thick, so the image focus in front of the retina**

2. *[because] the eyeball is too long*

Long-sightedness can be caused by:

1. [*because] the lens is too thin, so it focus behind the retina*

2. *[because] the eyeball is too short*

*responses orally modeled by the teacher.

Table II Language awareness criteria and relevant data

Language awareness criteria	**Data**
1. *Is the object of learning contextualized in a text?* For example, if the 'object of learning' is 'eye problems', does the teaching deal with it as a causal explanation, a description, a report of an experiment, and/or a historical recount of developments? Do the critical features explicitly identify a genre? Is the output of the post-test a text? (sections 3.0 & 3.1).	Lesson recording Slides with teaching aims; scanned materials; scanned tests; scanned student responses.
2. *To what extent is there explicit attention to the cognitive-academic language construing the science?* For example, does the teacher focus students' attention on the CAL *wording choices* of what s/he wants students to learn and do (section 3.3)? Do the critical features explicitly state, 'a causal explanation of eye problems, which is construed by wording *similar to* [Figure 1], with text architecture *exhibiting language choices and patterns* as in [Table 1]'? Is there scripting of teacher wording at significant teaching episodes, such as where a variation pattern is materializing?	Lesson recording. Slides with: details of teaching 'content' or the **object of learning** and its **critical features;** lesson outline; scanned teaching materials.

Table III Study 2 Teacher's boardwork

Who	**Can't see clearly**	**Where is image formed**	**Thickness of lens**	**Length of eyeball**	**How to correct?**	**Kind of lens**
Normal	-	onto the retina	normal	-	-	-
Peter	distant	in front of the retina - Blur [sic]	too thick	too long	bend light ray/diverge	concave
Mary	near	behind the retina - Blur [sic]	too thin	too short	converge	convex lens

Table IV: Use of Patterns of Variation (reproduced from slide 23, Presentation of Study 1)

Critical Features for discernment	Varied	Kept constant
Some metals react with acids while some do not	Metals	Acid Acid concentration
When a metal reacts with an acid, it is independent of the acid's concentration	Acid concentration	Acid Metal
When a metal reacts with an acid, it also reacts with all kinds of acids of different concentrations;	Acid types Acid concentration	Metal
The reaction taking place depends on the metal, not the type/ strength /concentration of the acid.	Metal Acid concentration	Acid

Appendix

Figure 1: Text architecture: Eye problems: process analysis

Genre: Causal explanation

Title: Eye problems

'When light from different parts of an object ***projects*** to the retina, an image is **made**. If light from different parts ***goes*** to the same part of the retina, the image **is** blurred. If we **make** the light ***project*** to different parts of the retina, the image **is** clear.'

Key: Bold= relational process; ***bold italicized= material process***

Table 1: Text architecture analysis: Eye problems

Grammatical resources	**Description of meaning making**
	Ideational meaning
Nouns	**Field:** A technical field is built up by: *light, retina, image* **Structure**: While some NPs are simple ('*the retina*'), several are more complex, with pre-modification e.g. *different parts,* and post-modification by two embedded prepositional phrases e.g. *light from different parts of an object* **Technicality**: Noun groups *light, retina* and *image* are 'technical' and 'abstract' cognitive-academic language (CAL words). **Distribution:** equal distribution of nouns and verbs indicates a pre-CAL, more spoken text. A more 'written' nominalized English CAL text is: *Light projection from different parts of an object creates an image. Light projection from different parts of an object to the same part of the retina blurs the image. Light projection to different parts of the retina clarifies the image*.
Verbs	**Process types** (see analysis above): Material processes construe the activity of the participant/Actor 'light' (*light projects, light goes*). Relational processes construe attributes (*the image is blurred/clear*). Causal relational verbs, without Actor or with Actor 'we' construe cause-condition (*an image is made; we make the light project)* **Structure**: Verb groups are often simple, but more complex groups are 'is made' and 'make project' (not found in the written CAL above).

Grammatical resources	**Description of meaning making**
Conjunctions	Conditional meaning is the most prominent, construed by 'when' and 'if' X happens
	Interpersonal meaning
Mood	Because the grammatical mood is exclusively declarative (Subject followed by Finite), the writer is positioned as 'teller' of information.
Tense and Voice	Exclusively present tense in active and passive voice construes the generalizable and timeless factuality of the propositions. Passive voice construes irrelevance of Actor.
Modality	Because there are no modal verbs, and no lexical modality, the writer positions the events as 'factual.'
Pronouns	Because the sole pronoun '*we*' refers to the doers of science (here, the students and teacher), the text is 'personal' and relatively more 'spoken' than, for example, written CAL.
Appraisal	Because there are no explicitly evaluative words, the wording is neutral. This construes scientific 'objectivity'.
	Textual meaning
Cohesion by reference lexis and Adjuncts	Because the word meanings are logically related, there is cohesion. *Light, projects retina, image, made, blurred, clear.* Because the reference is appropriate (*light> light > the light*: *an image> the image*) there is cohesion.
Theme (starting points of sentences)	The text comprises only two sentences. The chosen Themes, both clausal, provide a logical 'backbone' to the text: *When light from different parts of an object projects to the retina…> If we make the light project to different parts of the retina,….'*

Word count: 8,221