Zacharias, S. (2020) Towards a concept-driven pedagogy: a model of linguistic knowledge. In: Giovanelli, M., Harrison, C. and Nuttall, L. (eds.) New Directions in Cognitive Grammar and Style. Bloomsbury: London.

1. Introduction

Learning a new subject involves learning unfamiliar, discipline-specific, abstract concepts. In science, for example, students are expected to acquire and apply the concepts of power, life and energy. These discipline-specific concepts can be challenging for students to learn as they often differ from how the concept is used in everyday language (Scott et al. 2006). Furthermore, students' understandings of these concepts are expected to develop and change, often quite radically, as they progress through a unit of work or through school, college or in Higher Education. Equally challenging is the task of teaching these concepts, and evaluating students' conceptualizations, as evidence of a student's understanding of any new concept is primarily evaluated indirectly from their writing, speaking or from visual representations. These can be produced either in formal test situations or in during day-to-day classroom activities and interactions, which form part of a teacher's formative practices during which they evaluate their students' conceptual understandings. The language students use in these situations can seem, however, very 'messy' and difficult to interpret, since, as noted by van Lier:

> *speakers, in their use, give evidence of the mental life behind their utterances, by using words such as 'I believe that.. ',' 'it's like x,' 'that reminds me of ... ' as well as in a myriad of more covert and subtle ways .*
> *(1996: 174)*

Thus, evaluating a student's conceptual understanding is essentially interpreting language in use. Current practices in formative classroom assessment in all contexts have been critiqued in that they lack theoretical foundations (Taras 2010) and, more specifically, they are not based on any reliable models of cognition of situated learning in a classroom (Black and Wiliam 2009). Many teachers' judgements of their students' ideas and concepts are therefore often based on their own inferences during ongoing classroom situations. Such judgements are not generally open to scrutiny from others and may indeed be open to bias. Further still, teachers just starting out have little experience of evaluating their students' work and may be uncertain of how to form reliable judgements. As succinctly expressed by Perrenoud (1998: 95):

> *Without a theoretical model of the mediations through which an interactive situation [in the classroom] influences cognition, and in particular the learning process, we can observe thousands of situations without being able to draw any conclusions .*
> *(Perrenoud 1998: 95)*

This issue also faces the educational researcher who is interested in the effect that discourse and the social and physical environment of the classroom have on the development of conceptual thinking, as well as what Knowledge About Language (KAL) (Carter 1982) is required by teachers to support conceptual development in their learners. Without a suitable analytical framework, there exists no means of being able to systematically track how learners construct and represent their conceptual thinking during a learning episode or lesson.

This chapter proposes that such a framework needs to be based on a model of language and cognition that recognizes that language reflects how we conceptualize the world. This view of language is best articulated in the field of cognitive linguistics that includes Cognitive Grammar (henceforth Cognitive Grammar). The aim of this chapter, therefore, is to present a framework of linguistic knowledge based on a cognitive view of language, that has the potential to form the basis of KAL professional development sessions for teachers, and for researchers interested in classroom dialogue, especially in a secondary context. This is part of a concept-driven approach to pedagogy, first outlined by Giovanelli (2014), which places meaning, language and conceptual understanding at the heart of learning and teaching. Thus, it offers a principled approach to using students' language as evidence of their conceptual thinking which is of value not only to the teacher but also to the researcher interested in the role of language in conceptual development. The model I propose draws on principles from Cognitive Grammar and other cognitive linguistic frameworks, most notably Text World Theory (TWT) (Werth 1999; Gavins 2007).

The structure of this chapter is as follows: first, I provide a brief overview of some key research milestones that have led to a cognitive linguistics-informed view of the connection between abstract concepts, learning and language. After detailing how the empirical data used in the analysis of this chapter was collected from a secondary school, I will outline some key tenets of CG and TWT that underpin this chapter's theoretical framework and model of linguistic knowledge. By applying CG's and TWT's respective approaches to an analysis of spoken discourse, I will propose a model of linguistic knowledge that draws on principles of both CG and TWT, with Langacker's (2008a: 55) concept of construal positioned at its core. This model of linguistic knowledge will be applied to the analysis of two episodes of classroom discourse taken from one science lesson and a student interview, whereby a number of construal operations, shown to be significant for the interpretation of the learning process, are explored.

2. Abstract concepts, learning and language

Through language we refer to things that we can directly perceive either through our senses (e.g. book, table, dictionary) or to entities that are not directly available to us as they are more abstract. We are able to think and talk about internal states (love, motivation), social constructs (institution, school), human born creations (theory, argument), ethical values (social justice, morality) (see Bolognesi and Steen 2019: 1) and abstracted constructs of our perception and understanding of the physical and living world (energy, life). Establishing a sense of shared consensus in a classroom of what concrete entities are is generally far more straightforward than coming to an agreement on what is meant by an abstract concept. Current research on how children and young adults acquire conceptual thought can be traced back to Piaget (1926, 1932, 1985), who prefigures a central concern of successive research, namely, how humans are capable of constructing knowledge of the world by observing and acting in the physical world around them. He focused on how conceptual reasoning is represented in propositional structures in children's language. Consequently, much empirical research that is directly based on his work focuses on the logical reasoning of children and tends to be carried out in interviews away from the classroom (e.g. Tao et al. 2012). In contrast, influenced by the work of Vygotsky (1978), socio-culturalists focus on the social dynamics of the classroom and have noted the type of interactions that favour a convergence in understanding between the participants involved. While research based on Piaget and Vygotsky's work frequently uses language data, it generally does not involve a linguistic analysis of the language patterns used by learners to represent their conceptual thinking. One

notable exception to this is Seah et al.'s (2011) study which draws on Halliday's notion of social genre and register (Halliday 1994). It concludes that a group of middle school learners' conceptual understanding of heat expansion is directly influenced by their use of lexico-grammatical resources (Seah et al. 2011). The study notes that the more 'expert-like' their use of the scientific language after a period of instruction, the clearer their understanding of the scientific concepts seems to be. While this study is useful in that it focuses on the students' use of different academic registers, it is vague in how it determines the nature of students' conceptual understandings of the concept of heat expansion.

One important research project that does explore the learners' conceptual thinking is Deignan et al.'s (2017) recent study. This project is an investigation of secondary school students' understandings of the abstract concept of climate change and analyses students' use of domain-specific metaphors in group interviews. It then compares these findings to metaphor use in educational materials and specialist texts written by scientists. The study concludes that the students' use of metaphors tends to be more creative than its use in the other two sources which sometimes led the students to have inaccurate understandings of the science. This study is clearly significant and demonstrates how important it is for teachers to understand how metaphors work in their discipline. However, although metaphors play a key role in how scientists do and communicate science (Brown 2003; Reynolds 2018), I have recently shown that it is not the only cognitive process that is involved in the development of abstract thought in a naturalistic setting such as a classroom (Zacharias 2018, 2019). Indeed, as noted by Langacker (2008a), the metaphorical process is just one of several possible cognitive processes that are involved in the creation and use of abstract thought. Put simply, a linguistic expression imposes just one of many possible ways to conceptualize and represent a situation (Langacker 2013: 4): in other words, it may be construed in one of several different ways. Furthermore, as abstract concepts develop over time as a series of reconstruals within any learning situation, it is necessary to examine this phenomenon by exploring it at a discourse level to appreciate both the social and cognitive processes at work during their development.

3. Methodology

The linguistic model presented in this chapter developed as part of a cognitive discursive exploration of the development of abstract scientific concepts of heat energy in a secondary school science class (Zacharias 2018). More specifically, the context for the study was a first-year (11–12-year-olds) secondary class in an urban, state- maintained school in the UK. The class consisted of twenty mixed ability students from various socio-economic, cultural and linguistic backgrounds, representative of many city schools in the country. As the study aimed to understand the complex world of human mental experience and the role of discourse in the development of abstract concepts in a learning situation, a longitudinal case study design was adopted to gain close proximity to the conceptual world of the students. The data examined in this chapter focuses on an episode from one lesson and a student interview, which form part of the wider four-month study (Zacharias 2018). Confidentiality was ensured throughout the analysis by referring to the students with pseudonyms.

The learning events in this chapter were video recorded and later transcribed using Conversation Analysis notation (ten Have 2007) in order to represent the spoken interactions in a form that was close to their original. This process included transcribing, reading the transcripts after the events took place, reconstructing the events from fieldnotes, observing the video recordings and discussing the findings in interviews with small groups of students

and the class teacher during the study. These activities revealed aspects of the learning situation, most notably socio-interactional ones and the possibility of alternative interpretations that would have been otherwise difficult to detect (ten Have 2007). Thus, although the main cognitive linguistic analysis results from my response to reading the transcripts after the events took place, my interpretation of these transcripts was strongly influenced by a deep immersion and re-construction of the events made possible by my fieldnotes and recordings.

4. Theoretical framework

Originally, Werth draws on Langacker's CG for TWT's grammatical basis (1999: 43, 199). This was subsequently replaced by systemic-functional grammar terminology and description, reflecting the fact that both grammars are considered to be usage- based systems that share many key principles (Gavins 2007: 56). Recently, however, there have been calls to re-examine Werth's original inclusion of Langacker's CG system. As Nuttall claims, a '(re) adoption of Cognitive Grammar as the grammatical basis for close stylistic analysis enhances our ability to account for the experiential effects of specific stylistic choices during the text-world construction' (2018: 55). In this chapter, I demonstrate that although the TWT model, with its rich discourse-world account of context, offers a suitable overarching framework for conceptualizing the development of abstract thought amongst the participants in a classroom situation, the re-introduction of the CG model into the linguistic knowledge component of the TWT framework does indeed allow for a more fine-grained analysis of the cognitive effects of the linguistic structures at work during a learning episode. The relative affordances of each model will be outlined briefly in the following section, thus highlighting the need to integrate the two models.

As previously mentioned, it is important to examine the phenomenon of conceptual development in the classroom at the discourse level. According to Langacker, during any usage event, the speaker/hearer conceptualizes the immediate situation or the ground (Langacker 2008a: 78): this includes the speaker and hearer and where the event takes place and what is being said between them. To interpret this, the speaker/ hearer also needs to conceptualize a separate mental space to the ground, the current discourse space (CDS), which carries all the information needed to interpret what is being said (Langacker 2001: 145). Langacker acknowledges that in order to interpret the language, the speakers require support from the context of speech that includes 'the physical, mental, social and cultural circumstances' (Langacker 2001: 145). However, he is somewhat vague in what this entails, and he does not elaborate on how an individual speaker is able to conceptualize the ground in their own unique way. Langacker tends to explain the conceptualization process using a set of universal principles, ignoring the potential variation involved in how this process is experienced by individuals.

Moreover, Giovanelli and Harrison (2018) point out that although this structure provides a useful means to conceptualize a speech event and its surrounding context, it ignores how an onlooker might conceptualize the relationship between the two speakers and mentally respond to the exchange. In contrast, the TWT model allows for a multi-layered analysis that includes both participants and onlookers (e.g. researcher) and provides opportunities to account for individual variation in how the events are experienced both during and after the event has taken place by analysing transcripts of the dialogue.

Some key features of the text-world framework will now be described before highlighting why and how elements of the TWT framework can and should be integrated into Langacker's CG. TWT is a cognitive discourse grammar that provides a model of how language in use can be experienced and understood. It is based on the premise that in order to understand any form of language, we construct mental representations, or text-worlds, in our minds to achieve this. Text-worlds are similar to mental modals (Johnson-Laird 1983) which emerge in the minds of the participants (e.g. teacher, learners and/or on-looker) and are 'the conceptualization of that part of the discourse-world which is "in focus" for that part of the discourse [...] it is the situation depicted by the discourse' (Werth 1999: 86–7).
One distinctive feature of the TWT model that makes the ability to conceptualize possible is what TWT terms the principle of 'text-drivenness' (Werth 1999: 140). This accounts for how elements from the text trigger only the schematic knowledge of the receiver, required by him or her, to make sense of the situation. This knowledge is part of the discourse-world, which Werth defines as 'the situational context surrounding the speech event itself' (1999: 83). Comparable to Langacker's concept of the immediate situation or ground, the discourse-world is made up of the participants, the text, all the elements that the participants can perceive. It also includes all the knowledge and beliefs about the world and identities that the participants bring to a situation. However, in contrast to Langacker's ground, Werth's discourse-world model provides a more elaborate account of how the text and visible objects evoke 'a whole range of experience' by drawing on Fillmore's notion of 'frames' (Werth 1999: 43). The discourse-world consists of not only sense input but also 'what the participants can work out from their perceptions' (Werth 1999). This implies that the participants draw from their knowledge frames in order to conceive of (perceive, remember or imagine) a coherent 'state-of-affairs' (1999: 84), when either producing or interpreting a given discourse. The crucial point is that the discourse-world, in contrast to Langacker's ground, accounts more convincingly for the individual variation in how various events are experienced, making it ideally suited for analysing how individuals construct meaning in group settings such as a classroom. Figure 14.1 illustrates a generic discourse-world

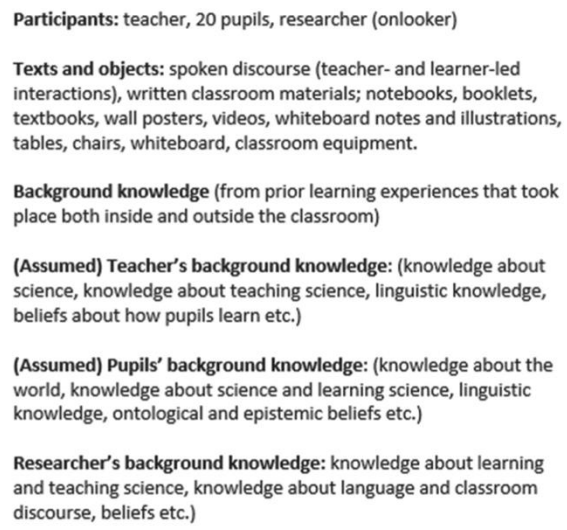

Figure 14.1 Generic discourse-world of the classroom.

of the classroom that I observed. The discourse-world of the classroom consists of not only the physical objects, such as tables and chairs, but also less tangible entities, such as mental states of the participants as they engage with the learning tasks.

Relevant to any classroom event is the background knowledge of prior learning experiences that the teacher and learners have as part of this discourse-world. This shapes their expectations, their ontological and epistemic beliefs, the power dynamics between them and the social interaction patterns that characterize classroom practice. The teacher will have accumulated over time knowledge about science and knowledge about how science can be learned, which automatically places the teacher in a privileged position relative to his or her learners. Accompanying this is how scientific knowledge can be constructed, represented and communicated in and through language; in other words, drawing on linguistic knowledge.

5. A model of linguistic knowledge

This section presents a model of linguistic knowledge (Werth 1999: 98) that borrows Werth's concepts of the discourse-world and text-world but places Langacker's concept of construal at its core. The model includes an elaborated and extended version of Werth's original model of linguistic knowledge with a re-introduction of CG (1991, 2008a), and Croft and Cruse's (2004: 46) synthesis of different kinds of construal phenomena, as the model's grammatical basis.

Werth's concept of linguistic knowledge is interlinked with other cognitive systems. In other words, linguistic knowledge, memories and experiential knowledge 'may all provide input for each other' (Werth 1999: 98). The meanings that the students ascribe to the words and structures they use have arisen from how they experienced the words previously either during the lesson or before: these words and structures 'propose a mode of construal of that entity' (Holme, 2009: 161). Fillmore already notes that our knowledge of lexis and grammar depends on 'contexted experiences; that is, the contexts within which we have experienced the objects, properties or feelings that provide the perceptual or experiential base of our knowledge of the meaning of the word (or phrase, or grammatical category) may be inseparable parts of those experiences' (1976: 24). Linguistic knowledge consists of not only knowing about lexis and grammar, but also what Fillmore terms as cognitive or interactional frames: a type of linguistic knowledge 'in which the language user interprets his environment, formulates his own messages, understands the messages of others, and accumulates or creates an internal model of this world' (1976: 23). This knowledge is essentially experiential, the kind of knowledge that exists as memories of prior experiences and is necessary if a concept is to be attained. Thus, learners acquire experiential knowledge of how lexical items and syntactical patterns have been used in context but also an inter-subjective understanding of the referents of those units by members of the discourse community to which they belong. The flipside of this is that by observing the students' language choices, it becomes possible to observe which part of the learning context they are choosing to foreground and attend to. This close relationship between thought and language in online situations is noted by Slobin (1996), in his 'thinking for speaking' conception, which claims that the language we use while speaking directs our attention to certain ways of filtering our experiences of the world. The educational practitioner interested in observing and examining their learners' conceptual development requires a means of detecting, however, how their learners gain this experiential knowledge.

Thus, Langacker's CG system offers a set of principles and concepts for the educational practitioner or researcher to explain how this experiential knowledge might be attained during a learning event in the classroom by providing a means of analysing the learners' lexico-grammatical resources in a systematic way. It enables the practitioner and researcher a

means to explore how learners develop abstract concepts by critically examining how particular events are construed in language during a learning event.
Langacker identifies several distinct construal phenomena that enable the speaker to conceptualize and portray a situation in several different ways (Langacker 2008a: 55). However, although Langacker's concept of construal is the key focus to this chapter's model of linguistic knowledge, this chapter uses Croft and Cruse's (2004: 46) topology of construal operations. This includes not only Langacker's proposal but also other key cognitive phenomena (e.g. image schemas and epistemic modality) that have been shown to play a significant role in the learning process (Zacharias 2018, 2019). Thus, the analysis in this chapter will focus on the following construal operations: schematization categorization, image-schemas (source-path-goal; container) and Hart's (2011) classification of epistemic modality.

By analysing the learners' output, then, it becomes possible to observe how the learner construes the learning event through the different lexico-grammatical structures he or she uses. These structures are not produced in isolation but are part of different rhetorical acts in the classroom (e.g. descriptions, explanations). These rhetorical acts or 'formal knowledge structures' (van Dijk 1980; Fillmore 1985) are a crucial part of the linguistic knowledge framework, as they serve an important organizational function in the knowledge building process. Such cognitive frames are strongly associated with the notion of prototypicality in that the receiver or producer of the knowledge structure needs to be able to categorize it according to the schema with which it corresponds. More recently, from the field of English for Academic Purposes, Bruce (2008) identifies these as 'cognitive genres' as they reflect how the mind organizes information to carry out these different rhetorical purposes. To summarize, the context of any classroom interaction will include knowledge about how language is used, knowledge of the ways in which learning can be presented and knowledge of particular rhetorical strategies to do so.

To illustrate the key features of this model, Table 14.1 shows the component parts of the linguistic knowledge framework that forms part of a participant's discourse-world during a learning event. It is worth noting that this linguistic knowledge is not a closed-off unit in the mind but part of an ongoing, dynamic system. Although Table 14.1 represents the component parts of this model as discrete entities, it is important to remember that in the context of a classroom interaction they work together with each other and other elements of the discourse-world to create meaning and new knowledge.

Table 14.1 The Linguistic Knowledge Framework

Component Part	Details
Lexical and syntactic constructional knowledge. Experiential knowledge (Fillmore 1976)	Knowledge of how lexical items and syntactic patterns are used in context. Shared understanding of what these items and patterns refer to within a discourse community
Construal operations (based on Croft and Cruse 2004: 46; Langacker 2008a) e.g. schematization, categorization, epistemic modality, image schemas, etc.	Ability to recognize item's structure as an instance of a prototypical schema (categorization) Recurrent dynamic pattern of perceptual experience (image schema)
Formal knowledge structures (Van Dijk 1980; Filmore 1985) **Cognitive genre** (Bruce 2008)	Knowledge of rhetorical purpose

6. Application of model of linguistic knowledge: Analysing classroom discourse

The following section exemplifies this framework in more detail by looking at how language is used in a specific educational setting. Although I primarily focus on the language of science I start by looking at how concepts develop across the disciplines. I will then demonstrate how the model of linguistic knowledge (as shown in Table 14.1) can be applied to students' language output to evaluate their conceptual understandings. I present episodes of transcribed spoken discourse from a biology lesson in addition to an interview with two first-year secondary science students. During these episodes, the learners' understandings of the scientific abstract concepts of living and insulation are explored. The learners' conceptual knowledge is analysed and evaluated by considering schematization, categorization, image schemas and epistemic modality, all construal operations (Croft and Cruse 2004: 46) that are found to play a key role in the development of conceptual thought in learners. Although the focus in the following section is on how these construal operations play a role in conceptual development, it should be noted that the learners' output triggers the formation of a text-world by the practitioner, researcher and/or text analysist. Therefore, references to relevant aspects of TWT are made throughout.

6.1 Schematization

Langacker (1987a: 371) refers to experiential knowledge as: an abstract characterization that is fully compatible with all the members of the category it defines [...]; it is an integrated structure that embodies the commonality of its members, which are conceptions of greater specificity and detail that elaborate the schema in contrasting ways.
Thus, an important aspect of linguistic knowledge is our ability to recognize the various symbolic units in our language as instances of abstract categories or schemas. Langacker refers to this ability as schematization (2008a: 17). For example, during a school day a learner may encounter the word 'water' in any number of different subjects that then activate various different knowledge frames associated with water. In geography, the focus of a description or explanation might be on the formation of rain clouds during an explanation of the water cycle or how the erosion of rocks can be brought about by the freezing of water. In art, the focus would be on the aesthetic features, in a physics lesson on its physical properties, such as that it boils at 100 degrees Celsius and freezes at 0 degrees Celsius. The point is, the learner encounters multiple experiences that vary in detail and content for the concept of water but extracts out of these experiences a conception of water at a higher level of abstraction: 'a liquid I see every day that may form ice or snow when cold'.

6.2 Categorization

Closely related to this is the ability to recognize that a symbolic unit is a typical example of a schema, in other words, the ability to see the symbolic unit as an instance of a prototype. This is referred to in CG as categorization (Langacker 2008a: 17). A young learner may have the following schema of metal, which has developed and acquired associations over time with other words such as shiny, hard, cold, gold, silver, iron, etc. However, on first encountering a metal such as mercury, a silvery, shiny metal that is, unlike many other metals, a liquid at room temperature, this learner may place mercury on the periphery of this category of 'metalness'. As this learner encounters further examples of metals in class and continues to explore their properties, these new set of metals may be categorized according to a refined set of core features. In other words, what the learner first thought to be a typical feature of a

metal (hard) may become less important as the learner encounters further examples of metals that are soft or liquid at room temperature. What the learner first considered to be a non-prototypical metal may gradually shift to a prototypical metal. The teacher plays a crucial role here in developing the concepts specific to the lesson, by foregrounding the associations appropriate to the focus of the lesson at the expense of others.

However, as noted by Sutton (1992), dismissing and ignoring the peripheral more idiosyncratic associations entirely may have undesired consequences in a school context. First, only giving prominence to the scientific meanings, the learner may soon feel alienated from the discipline as often the peripheral associations carry more emotive and personal associations. In terms of developing conceptual understanding, it might be beneficial also to see how the scientific meanings stand in relation to more idiosyncratic meanings held by the learner.

In contrast to the above example from the physical sciences, the following section will examine how learners might categorize the abstract concept of 'living' from the biological sciences. In the following episode, the teacher and learners each build their own mental space, or text-world, of the situation being discussed, namely, how to provide a scientific definition of living. The spoken discourse, that is part of the shared social space or ground, triggers text-worlds that are fleshed out by each participants' own discourse-world, including memories, beliefs, imagination and linguistic knowledge that they bring to the situation. Interestingly, here the learners chose to define 'living' by referring to real-world examples of living and non-living things they had encountered previously. In other words, they define living in terms of category membership either according to what it needs or how it behaves.

Episode 1: Abstract concept of 'living'

Mr D: *ok boys and girls (.) that's fine thank you very much (.) we go around a find out how you would define living (.) shall we start over here (.) go on then someone*

Kate: *we didn't know how to define it (.) so we thought about something that all living things need like every single thing that is living is water*

Mr D: *good that's ↑brilliant(.) one thing that living things do need is moisture dampness and water (.) brilliant fantastic do non-living things need that sort of thing I talked about? a pair of scissors(.) a pen well a pen? doesn't really need water(.) a pair of scissors doesn't really need water plastic doesn't really need water right anything else*

Kate: *um um like err they all they grow*

In the above example, the learners are drawing on their well-established encyclopaedic stores of experiential knowledge about living and non-living things that are accessed through the words 'all living things need', 'water' and 'grow'. Thus, by observing the learners' own language choices, it becomes possible to understand their conceptual understanding of the abstract concept of 'living' according to conventional norms of category membership.

6.3 Epistemic modality and image schemas

The following episode exemplifies how the construal operations of epistemic modality and image schemas play a crucial role in the development of abstract thought in social setting. It

demonstrates how, by examining how these construals operate during a learning event, the teacher or researcher is able to provide strong linguistic evidence for their learners' conceptions.

Episode 2 is an interview between the researcher, Sally, and two first-year secondary students, Sanja and Rose, that took place one week after a physics lesson on the abstract concept of insulation. In the lesson, the students carried out an experiment to find out whether a snowman with a jacket would melt faster than a snowman without a jacket. The purpose of the interview was to probe the students' reasoning further and to examine, using principles from CG and TWT, the students' understanding of the concept of insulation.

Episode 2: Abstract concept of 'insulation'

Sally: *u-huh ok can you explain your reasoning? why did you think that at the time?*

Sanja: *because I thought (.) like the jacket would ↑melt the snowman because it would bring a lot of heat to the snow (.) which would make it melt*

Sally: *yeah and Rose and you thought something slightly different didn't ↑you so can you remember what you thought at the time?*

Rose: *like if you put on a jacket it's not like (.) instantly warm (1.0) the body heat needs to heat up the jacket.*

Sally: *u– huh*

Rose: *so the jacket hadn't been on a radiator (.) or near any heat so if you put it on the snowman it wouldn't make any difference (.) and there's no like source of well there's the cold of the snow but it wouldn't keep him cold like*

Sanja: *at first I thought like (.) the cardboard would melt the ice (.) the snow it's trapped (.) and it has no way of like cold air to keep it (.) to keep it to keep it a ↑solid so I thought the heat would go to the snow*

Sally: *m-mh have you changed your view?*

Sanja: *yeah*

Sally: *and how have you (.) how do you think differently how would you explain that now?*

Sanja: *I think (.) I thought like the cardboard would melt the ice first (.) but when I saw the experiment I was actually quite ↑surprised Sally: u-huh?*

Sanja: *that the heat from the ↑sun would melt it first Sally: ok*

Sanja: *not the one without the cardboard*

Sally: *so (.) the cardboard (.) what is it doing what would you say its function is?*

Sanja: *I think it's trying to keep the cold (.) inside the space it's in.*

Not unsurprisingly, a strong feature of the discourse in this episode is the participants' use of epistemic modality to express their certainty and beliefs. Epistemic modality is classified in this chapter as a type of deictic construal operation which places propositions on a reality-irreality continuum. Both Langacker and Werth suggest that instances of epistemic modality are located by the conceptualizer at different points on this continuum (Langacker 1991; Werth 1999). Langacker (1991: 242) proposes the following cyclical structure to represent this dynamic process:

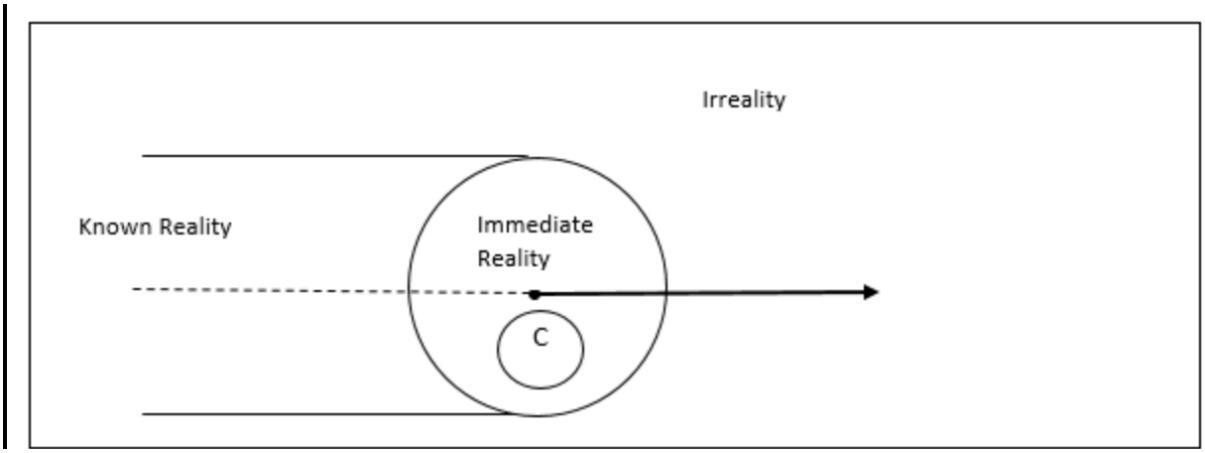

Figure 14.2 Langacker's reality-irreality continuum (based on Langacker 1991: 242)

In Langacker's model, 'known reality' is what the conceptualizer accepts as real and is generally what the conceptualizer (C) has perceptual access to at the time of the discourse event, or within 'immediate reality'. 'Irreality' is everything other than this known reality. There are varying degrees of reality known to the conceptualizer who is most likely to accept whatever he or she has perceptual access to at the time of speaking. What is accepted to be true by the conceptualizer grows during the discourse event, and that which lies beyond what is accepted to be true is irreal. This model is helpful as it provides a clear, visual aid (see Figure 14.2) to show how certain propositions are accepted to be more real than others by an individual speaker. What this model does not show, however, is how speakers draw from their own knowledge frames to assess the propositions as real or not. The TWT model offers a means to do this, in that it accounts for how a number of epistemic modal verbs (e.g. suppose, believe, think), modal adverbs (e.g. perhaps, maybe) and modalized questions 'can you explain?' can trigger the formation of an epistemic modal-world. Into this conceptual space the conceptualizer draws on their own knowledge frames to assess the evidence of a situation (Gavins 2007: 110).

During line 6 in episode 2, Sally establishes an epistemic modal-world with the question: 'can you explain your reasoning?' This modal-world is initially situated in the present time of the interview but shifts to a past time frame with: 'why did you think that at the time?' According to the reality-irreality continuum, the speaker does not have direct perceptual access to the past event and should therefore be less likely to accept the propositions pertaining to the event to be true. However, a past text-world can be experienced as a text-world aligned with the present, in that it can be compressed (Fauconnier and Turner 1998),

together with any text-worlds formed at the time of the interview, into a single continuous time-zone. It can therefore trigger the knowledge frames of the discourse-world of the interview to assess its credibility.

The students' responses describing their inner thoughts during the discussion (lines 7–32) are detailed and indicate a strong willingness to talk about their initial ideas. Sally's question, in line 6, triggers an epistemic modal-world in the past from Sanja. This co-constructed text-world becomes a shared conceptual space for Sanja and Rose to describe and assess their mental representations of the learning situation with the researcher Sally. What can be gleaned from Sanja and Rose's responses is that they draw from their own clothes schema. Here, the students draw on experiential discourse- world knowledge to evaluate the propositions within the epistemic modal-world set up by the question. They apply this knowledge to the everyday situation depicted in the task. In Sanja's response in lines (7–8): 'the jacket would ↑melt the snow because it would bring a lot of heat to the snow', the agency of the jacket is instantiated by its subject position. In this context, this implies that it causes the snow to melt and is the source of heat; it would bring heat. If this is interpreted literally, it might imply that the jacket generates heat energy.

The choice of the epistemic modal 'would' (line 7) can be explained by referring to the context. First, the scene is removed from the interview in both time and space and, therefore, is deictically removed from the learners' immediate surroundings. According to Langacker (1991), it will be experienced as less real than if the situation took place in the interview room. However, this explanation does not take into account the social dimension of the situation. Sanja and Rose have been asked to put forward opinions which might turn out to be wrong in front of the researcher, Sally, and the other participant. Therefore, the establishment of a more tentative, remote text-world to express their evaluations offers the participants a safe haven during the discussion. A language-aware teacher may be less inclined to interpret this hedged language as the learner simply not knowing or understanding as they would also take the social dimensions of the exchange into account. Accounting for the cognitive and social forces at play during problem-solving activities like this enables the teacher or researcher to systematically analyse and interpret the claims learners make, thus making the task of evaluating their conceptual understanding more robust.

During Sanja's response, it appears that two image schemas from her experiential discourse-world knowledge are employed to structure her reasoning. Briefly put, an image schema is 'a condensed redescription of perceptual experience for the purpose of mapping spatial structure onto conceptual structure' (Oakley 2007: 215) They are, as Langacker describes, 'preconceptual' structures that give rise to more sophisticated abstract concepts (Langacker 2008a: 32). First, Sanja uses the source-path-goal image schema (i.e. heat comes from the jacket and goes to the snowman), and second the container image schema ('at first I thought like (.) the cardboard would melt the ice the snow it's trapped (.) and it has no way of like cold air to keep it to keep it to keep it a solid') Here, the jacket is construed as a container. Although there is no clear referent for 'it' in 'it's trapped, from the co-text it might be assumed to be the warm air inside the jacket.

When Rose is asked to describe her inner thoughts, the source-path-goal image schema, which Sanja initiated with her implication that the jacket was a source of heat, appears to structure her reasoning too. Rose, however, contributes to the dialogue her knowledge that it is the human body which is a source of heat and not the jacket. In other words, Rose's schema of putting on clothes and understanding why they make you warm has a different and

possibly more elaborate structure to Sanja's as it acknowledges the role that body heat plays. Furthermore, Rose demonstrates a willingness to consider factors that either she had stored in her own schema before the lesson, or she had accreted (Stockwell 2020: 79) into her existing schema during the classroom discussion (see lines 14–16). For example, she mentions alternative sources of heat (e.g. radiator) that have not been mentioned previously in the interview.

In lines 24–5, Sanja describes the surprise she felt when observing the result of the experiment that the snowman without a jacket had melted first. On comparing the responses of Sanja, when she describes her initial ideas with those she had after observing the outcome of the experiment (line 27), she clearly demonstrates the need for an alternative explanation for what she has seen. In line 32, she provides a revised explanation for the phenomenon that she saw. Still using the container image

schema to structure her thoughts, she describes how the jacket traps the cold air on the inside thus maintaining a low temperature: 'I think it's trying to keep the cold (.) inside the space it's in' (line 34). This analysis has demonstrated how the both the source- path-goal and container image schemas structure Sanja and Rose's mental images during a problem-solving task. Both image schemas are essential to understanding the concept of insulation, yet this passage has shown that it is how they are aligned and positioned in relation to each other that matters.

7. Understanding and evaluating learners' responses

This chapter has argued and demonstrated that an approach to understanding language that is informed by principles from cognitive linguistics can provide both teachers and researchers a means to unpack learners' understandings of discipline-specific abstract concepts. The question remains, however: what are teachers and researchers evaluating their students' conceptual understandings against? To claim that they are simply assessing their students' conceptions against what has been written in the syllabus or against the assessment criteria does not highlight the role the teacher or researcher plays in interpreting their students' responses. A more accurate description of the process, that this approach affords, is that teachers and researchers understand and evaluate the effect the students' language has on their own minds against their own prototypical understandings of what they think the students' conceptualizations are and should be. These knowledge structures develop much in the same way as the linguistic knowledge structures that the students are developing through the verbal and non-verbal interactions they have with their social and physical environment during any learning event.

By comparing their students' responses with these 'idealised models of reality' (Gavins 2007: 5), teachers are in a position to develop their classroom practice, which includes being able to formatively assess their students' work. For example, with the case of the snowman problem-solving task a teacher could assess a students' work against their own prototypes of container and source-path-goal image schemas, and possibly additional structures, such as a blockage or restraint image schemas that represent the jacket as an insulator that slows the movement of heat entering the space inside the jacket with the snow. These knowledge structures underpin aspects of cognition that govern the production of both written and spoken language, as well as visual representations. Teachers equipped with the knowledge of how these image schematic structures shape and are shaped by language during learning events in their classroom, for example, would therefore be in a position to harness the visual aspect

underpinning their learners' language choices, use this to negotiate meaning, as well as better understand and interpret their learners' responses during classroom activities.

Although our knowledge structures may resemble each other, I have demonstrated in this chapter that they also vary between individuals. Classroom dialogue affords the possibility both to communicate the features of our mental models to each other and to fine-tune our own mental models in response to comparing ours to others. I argue that this emphasis on observing the cognitive effects of the language in the classroom, as opposed to focusing simply on the form of the language, allows teachers to place meaning in a more central position, thus opening an opportunity for undertaking a more critical and principled approach to teaching, learning and formative assessment.

8. Conclusion

Since CG is a usage-based approach and places meaning as central to language, it has the potential to offer teachers, students and researchers a powerful set of concepts and tools to analyse language-in-use (Langacker 2008b). This chapter tests this claim by applying the concept of construal to a series of learning episodes from a science lesson and a researcher-student interview, thus illustrating how, by analysing students' classroom language, it is possible to make useful inferences into the learners' conceptual processes, and therefore a means to systematically evaluate students' understandings of disciplinary-specific abstract concepts. One important aspect of cognition that has not yet been addressed in this chapter, but one that plays an important role in the development of abstract thought, is that of memory. Linguistic and experiential knowledge structures used to construct and represent concepts draw from different levels of memory (van Dijk and Kintsch 1983; Macnamara and Magliano 2009; Steen 2017). The level of memory these structures are accessed from will influence the degree of understanding of the abstract concepts displayed in the learners' language. Although Werth acknowledges that both memory and linguistic knowledge are interlinked, a more feasible account of how these two aspects of cognition are related would be welcome. Understanding this more fully would be a fruitful area for future research.

In this chapter, I have argued that, despite the CG model offering a plausible explanation for the experiential effects of language, it does not provide a clear account of the individual variation involved. Drawing on Werth's notion of discourse-world, I have proposed a model of linguistic knowledge that merges in elements of the TWT framework, thus extending Langacker's model to make it more suitable for analysing dynamic, socially embedded patterns of language-in-use, such as those found in a classroom context.

Transcription conventions:
↑↓Arrows indicate marked shifts into higher or lower pitch after the arrow
(.) Short pause
(3.0) Pause of 3 seconds

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