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RESEARCH

Reading Multimodal Texts for Learning – a Model for Cultivating Multimodal Literacy

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The re-conceptualisation of texts over the last 20 years, as well as the development of a multimodal understanding of communication and representation of knowledge, has profound consequences for the reading and understanding of multimodal texts, not least in educational contexts. However, if teachers and students are given tools to "unwrap" multimodal texts, they can develop a deeper understanding of texts, information structures, and the textual organisation of knowledge. This article presents a model for working with multimodal texts in education with the intention to highlight mutual multimodal text analysis in relation to the subject content. Examples are taken from a Singaporean science textbook as well as a Chilean science textbook, in order to demonstrate that the framework is versatile and applicable across different cultural contexts. The model takes into account the following aspects of texts: the general structure, how different semiotic resources operate, the ways in which different resources are combined (including coherence), the use of figurative language, and explicit/implicit values. Since learning operates on different dimensions – such as social and affective dimensions besides the cognitive ones – our inclusion of figurative language and values as components for textual analysis is a contribution to multimodal text analysis for learning.

Keywords: multimodal text analysis; text model; learning resources; multimodal literacy; multimodality

Introduction and background

Over the last few decades we have seen a growing consensus that becoming familiar with the discourse of the content area is at the core of meaning making and learning in any school subject or academic discipline (Halliday & Martin, 1993; Lemke, 1990; Norris & Phillips, 2003; Wellington & Osborne, 2001). Many descriptions of disciplinary (or subject) discourses have focused on the ways in which writing[1] (e.g. terminology, phrases, and text structure), in particular, is used in different contexts (Halliday & Martin, 1993; Schleppegrell, 2004). From such descriptions, frameworks for explicit focus on language and content in relation to written texts have been developed, some of which are more or less connected to genre based pedagogies developed in Australia (Christie & Derewianka, 2008; Gibbons, 2002; Martin & Rose, 2012). Also, more general frameworks for scaffolding reading comprehension in school contexts have been developed, mainly to help students become active readers, capable of monitoring their reading (e.g. *Questioning the author*, Beck & McKeown, 2006, *Reciprocal Teaching*, Palincsar & Brown, 1984).

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These models, and much of earlier analyses of disciplinary discourse as such, are more or less biased towards verbals (writing and speech) rather than seeing all meaning making as multimodal (see Kress, 2009, or Norris, 2011, for discussions). However, multimodality is ubiquitous in any discipline as well as in learning resources at all levels, and a number of scholars have pointed out the challenges for students regarding the ways that different meaning making resources are used and combined (Danielsson, 2013; Danielsson, accepted; Kress et al., 2001; Kress et al., 2004; Lemke, 1998; Tang & Moje, 2010; Tang et al., 2014, Unsworth; 2001). One example is chemistry texts, where the "same" scientific content such as 'ionic bond' is usually represented in different ways (through words, chemical symbols, images, etc.), and where each resource highlights certain aspects of the ionic bond; we cannot presume that all students can work out why the different meaning making resources are used and combined in particular ways by themselves.

Also, at a general level, in the last century there has been a gradual change in knowledge representation in paper-based pedagogic texts, from writing being the dominant representational resource towards a greater use of various kinds of illustrations (Bezemer & Kress, 2008). This is of course just as true for pedagogic texts in digital environments. Since the use of various semiotic resources to carry important information is prevalent in all pedagogic texts,

reading such texts involves being able to make meaning from multiple semiotic resources.

Previously, the ways in which different semiotic resources are used in texts have typically been discussed in relation to the specialisation of modes (*cf. modal affordance*) (Kress, 2003), with images being described as especially apt for aspects such as spatial information, and speech or writing for logic reasoning or sequential information. However, this is a simplification (see Unsworth, 2007, for a discussion), and in learning contexts it is important to scrutinise the various resources and the interplay between them. Thus, to harness students' meaning making in any discipline, a multimodal perspective of the ways in which subject content is expressed is essential.

Model for working with multimodal texts in education

Table 1 presents our model for working with multimodal texts in education. In the development of the model we have drawn on the social semiotic, multimodal perspective of meaning making (Bezemer & Kress, 2008; Jewitt 2005, 2009; Kress & van Leeuwen, 2006; Selander & Kress, 2010), specifically so in subject-oriented knowledge domains (for an overview, see Danielsson & Selander, 2014). The model is empirically grounded on a number of classroom studies revealing that meta-textual discussions are generally scarce in classroom practices. This is particularly the case in relation to multimodal aspects of texts (e.g. Danielsson, 2011; Løvland, 2010).

In addition to focusing on the general structure of texts and the interplay between different resources, the model includes the use of figurative language (such as metaphors, Cameron, 2002[2]), as well as values.

Metaphors and analogies, which can be expressed through writing as well as through images, are part of disciplinary discourse and they also have the potential to highlight specific aspects of the content. However, the use of metaphors has also been noted to be potentially problematic, for instance if students take the analogy too far (e.g. Haglund, 2013; Danielsson, Löfgren & Pettersson, accepted). An example from chemistry classrooms is the metaphoric use of electronic "shells" when explaining the ways in which electrons move around the nucleus at a certain distance. This metaphor can give an impression that there are actually shells where electrons can be placed. In a classroom study students sometimes talked about an "empty shell" as a result of ion formation when valence electrons "leave" an atom (Danielsson, 2011).

Values, both explicit ("you should eat healthy food") and implicit ("Huowei skipped breakfast; therefore he is tired"), can be expressed through different semiotic resources. Since images can be used to convey values in implicit ways, multimodal perspectives have previously proven fruitful for such analyses (e.g. Kress and van Leeuwen, 2006), something which has also been emphasised in relation to pedagogic texts (e.g. Unsworth, 2007).

Included in the model are comments on how teachers and students can work stepwise with unfolding the text and supporting meaning making around the content. This is important, not the least due to the fact that the novice in a field of knowledge cannot be expected to be able to fill in the missing parts, or make explicit the implicit links or relations between different pieces of information. Altogether, the different aspects of the model underpin the development of meta-cognitive skills through an understanding of how different resources operate to represent knowledge.

As mentioned earlier, a number of frameworks for working with texts have been developed previously, but these have often been biased towards writing, thus disregarding other aspects, such as the use of images or visualisations. Examples of exceptions of this are a model presented by Unsworth (2001) and the framework *Multimodal Analysis Image* (Tan et al., 2012). In comparison to those models, our model has a stronger focus on subject content and meta-textual classroom discussions. Thus, it has a double benefit in that the model supports students understanding of content at the same time enhancing their multimodal literacy.[3]

	Multimodal text focus	**Classroom focus**
General structure – setting	Thematic orientation and sequencing (What is the text about and how is the content arranged?)	Examination of the different parts of the text and what content they provide
	What do each one of the resources express? (images, diagrams, headings, introductory paragraph, etc.)	
Interaction between textual parts	Proximity/closeness and coherence between writing and other semiotic resources	Reflection as to the interaction between different resources and what aspects of the content that appear as central
	Congruence and coherence between concepts, descriptions and explanations	
Figurative language (in writing and images, etc.)	What analogies and metaphors are used?	Deconstruction of the figurative language. How far do the analogies reach, and how well do they function for the specific content?
Values	Explicit	Discussion of aspects such as right/wrong, us/the others, female/male, etc.
	Implicit (e.g. in metaphors, images, perspectives)	

Table 1: Model for working with multimodal texts in education (translated from Danielsson & Selander, 2014[4]).

Due to the limitations of an article of this format, in the following we will concentrate on two textbooks in one subject to illustrate the different parts of the model (in Danielsson & Selander, 2014, examples from a variety of disciplinary texts are used). Here we have chosen to analyse some sections in science textbooks. Science as a discipline is characterised by its use of multiple resources for meaning making in parallel, e.g. writing, graphs, symbols and visualisations of different kinds (Halliday & Martin, 1993; Schleppegrell, 2004; Lemke, 1998). In the following we will comment on a number of book spreads in sections on human digestion. One book is Singaporean, used for lower secondary school (students aged around 14); the other one is Chilean, used for middle grade students (students aged around 11) (**Figures 1–6**). The point here is not to make any kind of comparative cultural analysis. Instead, we want to demonstrate that the framework is versatile and applicable across different cultural contexts, with a focus on how the orchestration of multimodal modes has consequences for the reading as well as the understanding of the content. Here we concentrate on paper-based pedagogic texts. With minor adaptations the model can also be used for digital texts involving resources like moving visuals, sound, and hypertexts.

General structure – setting

The analysis of the general structure, sequencing and thematic orientation of the text can be connected to the notion of *setting* in the designs for learning framework (Selander & Kress, 2010). In our model, the concept is used to capture the ways in which a text "invites" its reader and calls for certain types of activities by its means of representing the content area. Here we start by looking at the *thematic orientation* and *sequencing* of the text, and then go on to examining what content is offered through the various resources on the page, such as different kinds of images, headings, and text boxes. At this stage, the text is examined at a relatively general level, both as regards layout and content. For meta-textual discussions in the classroom, this is a suitable starting point, and even quite young students can be involved in such discussions. Things to highlight in such discussions could be what content seems to be expected to be found in the text (from the information that, for instance, headings and illustrations give the reader), what resources "stand out", what roles different types of illustrations seem to play, and if there seems to be an expected way to go about reading the text.

The top image in **Figure 1** shows the starting point of the chapter "Human digestive system" in the Singaporean textbook. The left page is the first one of the introductory section headed "Why is the digestive system important?". This heading provides the students with the main concept, "the digestive system", and by expressing the heading as a question the intention seems to be to draw the students into the content by making them curious to find out the answer.

The chapter as a whole has a structure that evolves from a direct connection to students' everyday life to a purely scientific approach to the content. It starts off with a short text about a boy who has skipped breakfast and therefore is feeling hungry and weak. Then a table presents nutrients with comments on their molecular sizes, function and examples of food in which they can be found (see top image, **Figure 1**). Through this table the reader is taken one step further into the scientific aspects of the content. The remaining part of the chapter on the human digestive system mainly deals with the system from a scientific point of view, including chemical aspects of digestion (e.g. bottom image in **Figures 1, 2** and **3**).

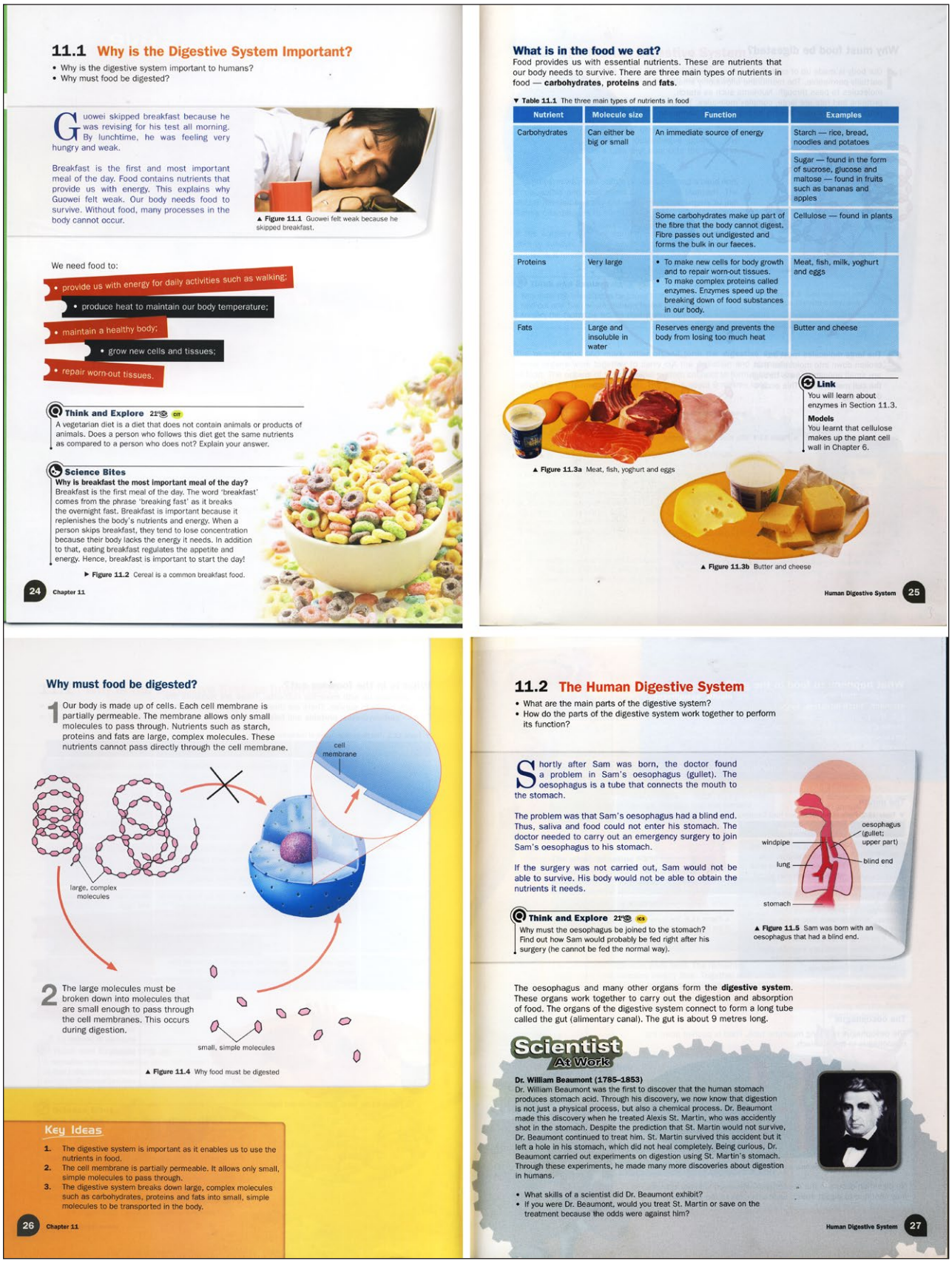
Even though the chapter takes on a gradually more scientific approach, different activities, sometimes labelled 21st Century Skills (e.g. **Figures 1, 3** and **4**) connect the topic to the students' everyday lives throughout the chapter. Towards the end of the chapter, the human digestive system is summarised in a flow chart (**Figure 4**). It is worth noting that it is only until the flow chart at the end of the chapter that the terms *physical* and *chemical digestion* are presented even though the terms are used throughout the chapter.

Similarly to the chapter in the Singaporean textbook, the Chilean textbook starts out with a question as a heading ("¿Cómo funciona nuestro cuerpo?", *Eng.* 'How does our body function?'), inviting the reader to learn more (**Figure 5**). Here, the starting point is a series of pictures (resembling a comic strip) over the double page spread in which two children decide to make an imaginative journey through "the body". The journey goes from the stomach to the heart via the blood and after a detour to the lungs back to the blood circulation, it finally ends with the children floating in urine in a bladder. During the journey the two children note things such as nutrients and oxygen entering into the cells of the organs.

Under the heading "Observo y respondo" (*Eng.* 'Observe and respond'), students are given questions that are supposed to make them read the comic strip more closely, for example by questions about what different organs in the body the children encounter. On the left page of the double page spread, a number of questions invite the reader to describe, for instance, the essential functions of different body systems. However, there is no explicit information in the comic strip that gives specific information about these systems.

The following pages in the Chilean book go deeper into the subject specific content. Here we can note that the series of pictures (**Figure 6**) gives gradually more abstract and detailed representations of parts of the intestines, starting with a photo of a child eating an apple, ending with an image of a cell which is said to be one of the many cells building up the intestines.

In the comic strip as well as in the verbal text accompanying the illustrations in **Figure 5**, scientific terminology connected to the topic is used frequently. The following section deals with the physical and chemical aspects of the digestive system. Here labels give the scientific concepts connected to the human digestive system presented in an image (not shown in the examples), similar to the Singaporean book spread in **Figure 2**. An explanatory text describes the kind of processes that goes on in the various parts of the system shown in that image.



11.1 Why is the Digestive System Important?

- Why is the digestive system important to humans?
- Why must food be digested?

Guowei skipped breakfast because he was revising for his test all morning. By lunchtime, he was feeling very hungry and weak.

Breakfast is the first and most important meal of the day. Food contains nutrients that provide us with energy. This explains why Guowei felt weak. Our body needs food to survive. Without food, many processes in the body cannot occur.

▲ Figure 11.1 Guowei felt weak because he skipped breakfast.

We need food to:

- provide us with energy for daily activities such as walking;
- produce heat to maintain our body temperature;
- maintain a healthy body;
- grow new cells and tissues;
- repair worn-out tissues.

Think and Explore 21st CCT

A vegetarian diet is a diet that does not contain animals or products of animals. Does a person who follows this diet get the same nutrients as compared to a person who does not? Explain your answer.

Science Bites

Why is breakfast the most important meal of the day?

Breakfast is the first meal of the day. The word 'breakfast' comes from the phrase 'breaking fast' as it breaks the overnight fast. Breakfast is important because it replenishes the body's nutrients and energy. When a person skips breakfast, they tend to lose concentration because their body lacks the energy it needs. In addition to that, eating breakfast regulates the appetite and energy. Hence, breakfast is important to start the day!

▶ Figure 11.2 Cereal is a common breakfast food.

What is in the food we eat?

Food provides us with essential nutrients. These are nutrients that our body needs to survive. There are three main types of nutrients in food — **carbohydrates**, **proteins** and **fats**.

▼ Table 11.1 The three main types of nutrients in food

Nutrient	Molecule size	Function	Examples
Carbohydrates	Can either be big or small	An immediate source of energy	Starch — rice, bread, noodles and potatoes
			Sugar — found in the form of sucrose, glucose and maltose — found in fruits such as bananas and apples
		Some carbohydrates make up part of the fibre that the body cannot digest. Fibre passes out undigested and forms the bulk in our faeces.	Cellulose — found in plants
Proteins	Very large	• To make new cells for body growth and to repair worn-out tissues. • To make complex proteins called enzymes. Enzymes speed up the breaking down of food substances in our body.	Meat, fish, milk, yoghurt and eggs
Fats	Large and insoluble in water	Reserves energy and prevents the body from losing too much heat	Butter and cheese

Link

You will learn about enzymes in Section 11.3.

Models

You learnt that cellulose makes up the plant cell wall in Chapter 6.

▲ Figure 11.3a Meat, fish, yoghurt and eggs

▲ Figure 11.3b Butter and cheese

Why must food be digested?

1 Our body is made up of cells. Each cell membrane is partially permeable. The membrane allows only small molecules to pass through. Nutrients such as starch, proteins and fats are large, complex molecules. These nutrients cannot pass directly through the cell membrane.

2 The large molecules must be broken down into molecules that are small enough to pass through the cell membranes. This occurs during digestion.

▲ Figure 11.4 Why food must be digested

Key Ideas

1. The digestive system is important as it enables us to use the nutrients in food.
2. The cell membrane is partially permeable. It allows only small, simple molecules to pass through.
3. The digestive system breaks down large, complex molecules such as carbohydrates, proteins and fats into small, simple molecules to be transported in the body.

11.2 The Human Digestive System

- What are the main parts of the digestive system?
- How do the parts of the digestive system work together to perform its function?

Shortly after Sam was born, the doctor found a problem in Sam's oesophagus (gullet). The oesophagus is a tube that connects the mouth to the stomach.

The problem was that Sam's oesophagus had a blind end. Thus, saliva and food could not enter his stomach. The doctor needed to carry out an emergency surgery to join Sam's oesophagus to his stomach.

If the surgery was not carried out, Sam would not be able to survive. His body would not be able to obtain the nutrients it needs.

Think and Explore 21st ICS

Why must the oesophagus be joined to the stomach? Find out how Sam would probably be fed right after his surgery (he cannot be fed the normal way).

▲ Figure 11.5 Sam was born with an oesophagus that had a blind end.

The oesophagus and many other organs form the **digestive system**. These organs work together to carry out the digestion and absorption of food. The organs of the digestive system connect to form a long tube called the gut (alimentary canal). The gut is about 9 metres long.

Scientist At Work

Dr. William Beaumont (1785–1853)

Dr. William Beaumont was the first to discover that the human stomach produces stomach acid. Through his discovery, we now know that digestion is not just a physical process, but also a chemical process. Dr. Beaumont made this discovery when he treated Alexis St. Martin, who was accidently shot in the stomach. Despite the prediction that St. Martin would not survive, Dr. Beaumont continued to treat him. St. Martin survived this accident but it left a hole in his stomach, which did not heal completely. Being curious, Dr. Beaumont carried out experiments on digestion using St. Martin's stomach. Through these experiments, he made many more discoveries about digestion in humans.

- What skills of a scientist did Dr. Beaumont exhibit?
- If you were Dr. Beaumont, would you treat St. Martin or save on the treatment because the odds were against him?

Figure 1: Food digestion, lower secondary school (Science Matters, pp. 24–27).

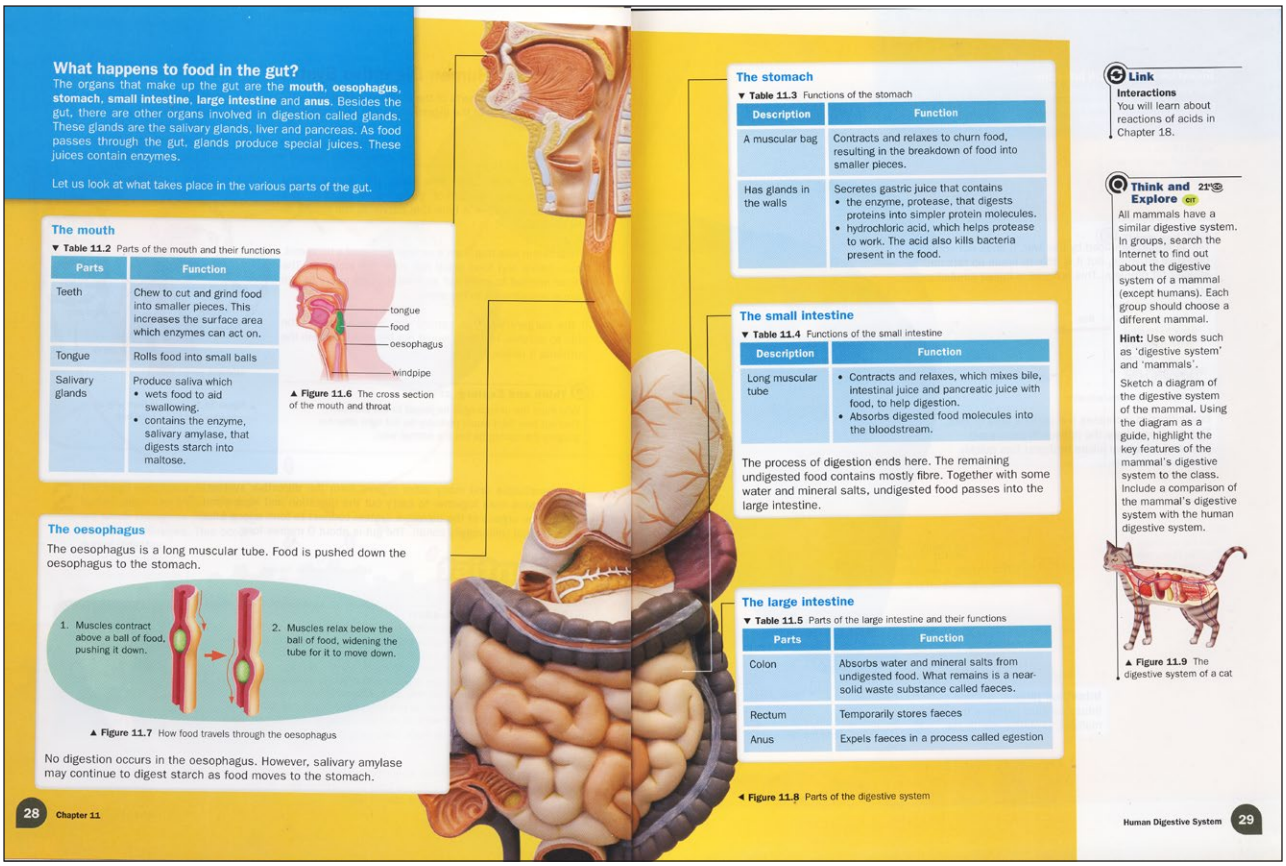


Figure 2: Food digestion, lower secondary school (Science Matters, pp. 28–29).

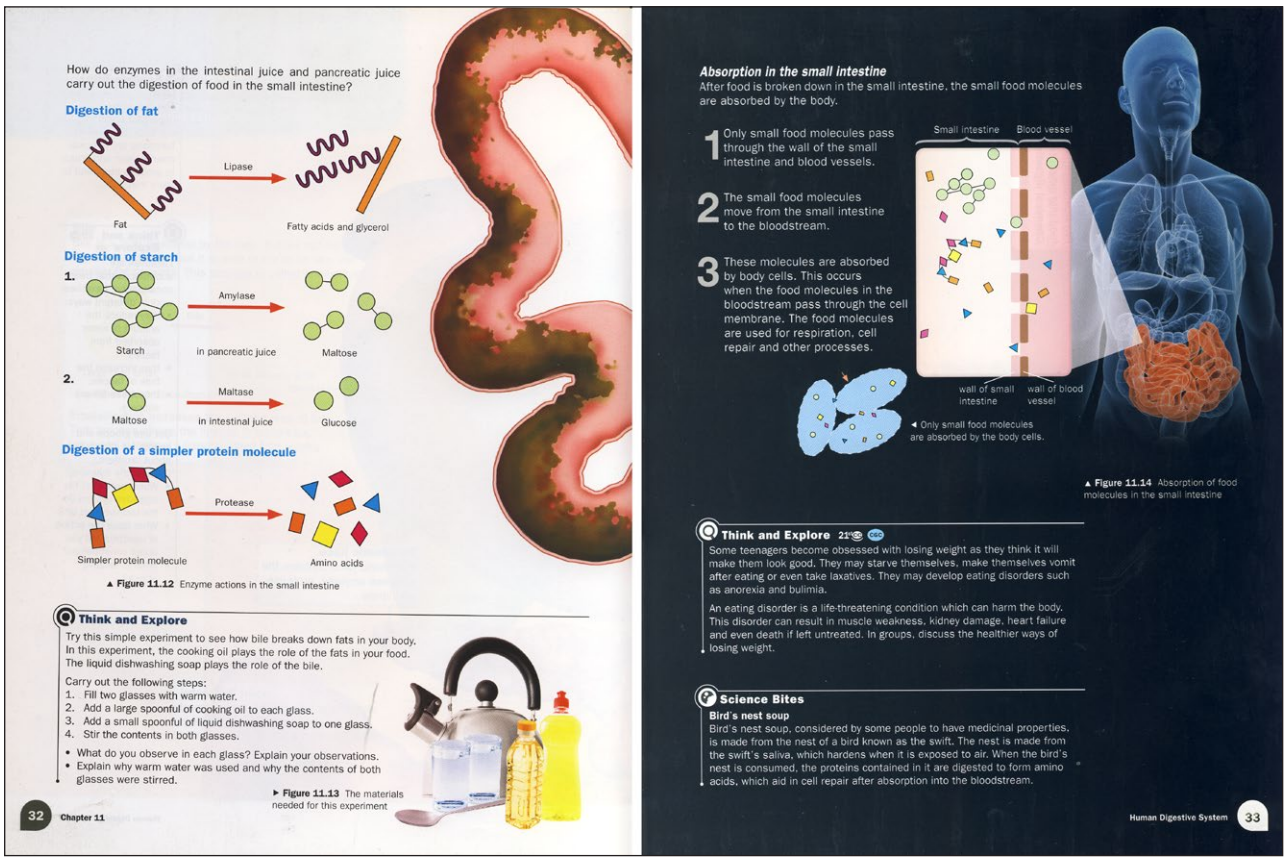


Figure 3: Food digestion, lower secondary school (Science Matters, pp. 32–33).

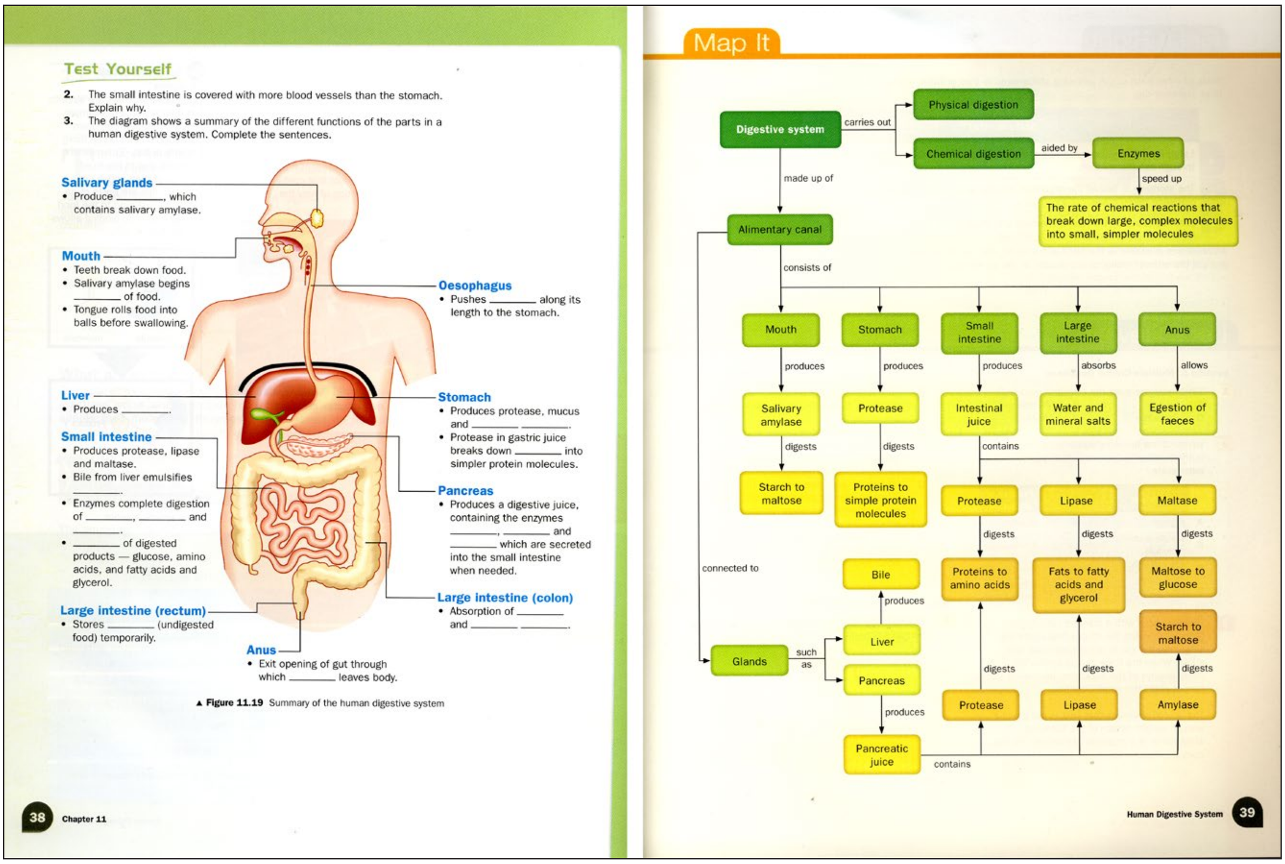


Figure 4: Food digestion, lower secondary school (Science Matters, pp. 38–39).

Figure 5: Food digestion, middle school (Ciencias Naturales, pp. 8–9).

As we can note from the analysis of the thematic structure in the books, there are similarities between the texts. Both texts invite the reader to the content by using questions as headings, and they both use a connection to the students' everyday lives as a starting point.

Sequencing deals with text structure at a general level, for example to what extent the information structure invites the reader to read the different parts of the text in a certain order. From a brief look at the book spreads in **Figures 1–6**, we can note that only the text in **Figure 6**, taken from the Chilean book, has a traditional structure, with a body text clearly separated from the illustrations. Another way of sequencing is found in the book spread from the Singaporean textbook in the bottom image **Figure 1**. The left page is dominated by the image depicting a cell. Such a prominent image, both in relative size and central placement, draws the attention to that area of the page (see Kress & van Leeuwen, 2006, for a discussion of prominence). At the same time, the numbers 1 and 2 imply a reading order starting at 1. This type of visualisation, with the prominent image of the cell, including a zoom-in on a cell-membrane alongside with numbered text sections and arrows is common in pedagogic texts. Such visualisations imply a reading order following the arrows, where the reader is supposed to juggle between verbal text and visualisations, using the arrows to follow a process. However, in this case the numbered arrows have partly different functions, with two arrows (one crossed over, being a "dead end") pointing at divergent directions from the verbal text numbered "1". The arrow which is crossed over functions as a notice that big molecules cannot pass into the cells, and therefore (which is not stated explicitly) we need the digestive system to make big molecules smaller. Thus, drawing attention to the general overview and the ways in which the reader is "invited" into the text can function as a form of guidance for the students, at the same time as possible challenges (like the use of arrows for different purposes in the visualisation) can be highlighted in such discussions.

With regard to what the different semiotic resources are used for, we concentrate mainly on the book spread shown in the bottom image in **Figure 1**. This spread contains images of various kinds (abstract images, like the human cell and the molecules, as well as more realistic images, such as the black and white photo/drawing of a scientist), verbal text in different forms, for instance body text, headings of various levels, and words integrated in visualisations.

The image on the left page is used for showing aspects like wholes/parts of the cell and for giving a more concrete image of abstract content (simple and complex molecules). At the same time it gives a kind of time sequencing (large molecules breaking down to smaller molecules) and processes (simple molecule passing through the cell membrane). This explanatory use of the image can be compared to the more illustrative images on the previous spread (top image **Figure 1**), with the tired boy resting his head on a desk, and food on plates, or the schematic image on the left page labelling different parts of the upper digestive system.

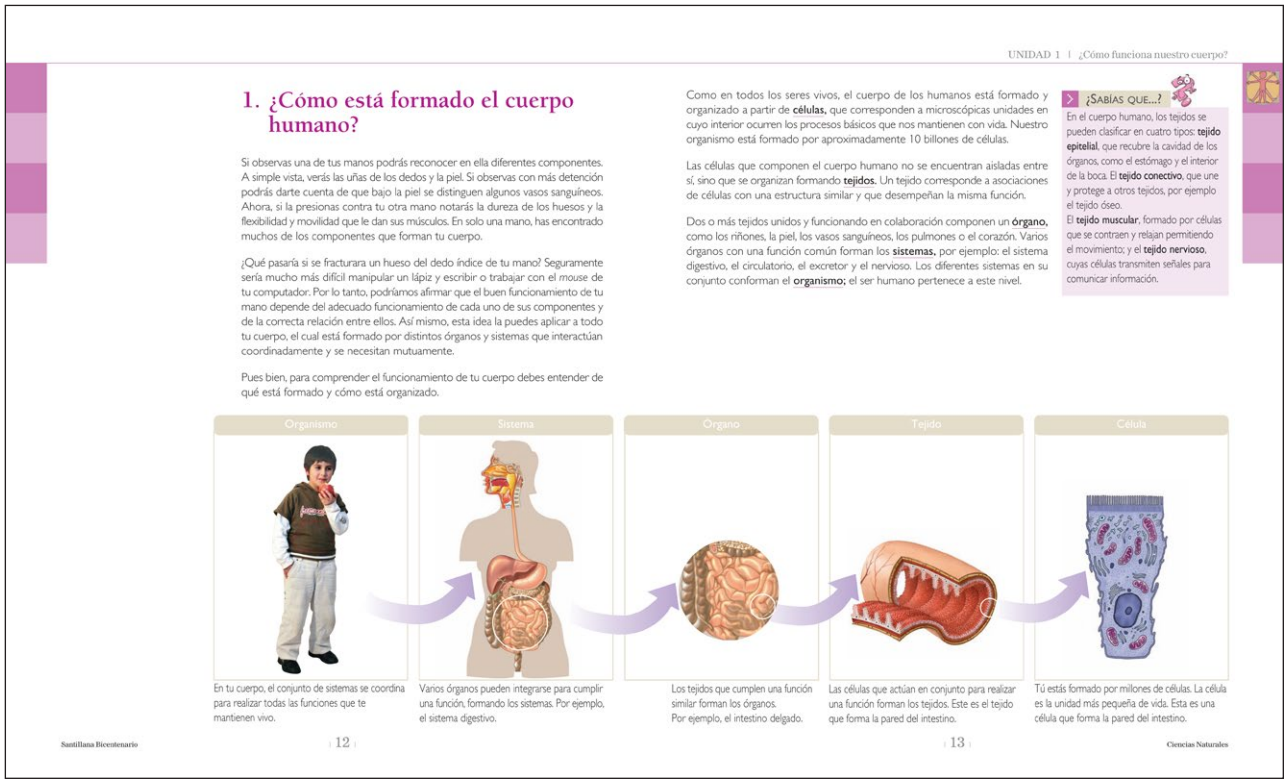


Figure 6: Food digestion, middle school (Ciencias Naturales, pp. 12–13).

Also, various kinds of graphic devices are used in this book spread, for example textboxes and bolded words in the body text. The use of textboxes of various kinds is common in textbooks. In the Singaporean book, textboxes are used to mark key ideas, using an explicit heading. Throughout the book, recurrent activities intended for the students to go beyond the immediate "facts" in the book to connect them to real life situations are marked "Think and Explore" with an explicit connection to "21st Century Skills". The Chilean textbook also provides the reader with a number of key concepts in a textbox (**Figure 6**, upper right): in this case different types of body tissues (*Spa.* 'tejidos'), which are given in bold text. However, this information is given under the heading "¿Sabias Que. . . ?" (*Eng.* 'Did you know?'). Such headings are quite frequently used for texts intended to raise the curiosity of the reader, but perhaps giving less important information.

Since there are no "rules" as to how to use different graphic devices in a text, there are good reasons to discuss and make explicit how different resources are used when introducing a new text in an educational context.

Interaction between textual parts

An important aspect of multimodal texts in learning is the relationship between the different semiotic resources on the page (or equivalent), and the different ways the resources are used for expressing various aspects of the content. Here we also examine to what extent the different resources give the same, overlapping, or different/supplementing information (see also Unsworth, 2007). When different resources supplement each other, they can sometimes appear to give partly contradictory information. One such example could be when a concept like the atom is presented as a static phenomenon consisting of various particles in an image, while at the same time other resources like verbal text or gestures (in the classroom practice, or in a video) focus on the dynamic aspects of the atom, with electrons swirling around a nucleus (e.g. Danielsson, accepted).

Both students and teachers tend to view images of various kinds as a way of facilitating the reading of a complex text (Danielsson, 2011), and they can of course be used to visualise or simplify a complex phenomenon or reasoning. However, images might also add new, complex – or contradictory – information. Therefore, images too can be challenging for the interpretation of the text.

In addition to consider the options as to what content should be given in images (and why), a number of other choices have to be made as to *how* to depict the content (photo, drawing, graph, etc.) or what level of abstraction that would be suitable for the content in relation to, for example, the intended target group. Here we can make interesting comparisons between the series of pictures in **Figure 6** and the image in **Figure 3** (right page), which to some extent are used for parallel content, such as the fact that the intestines play an important role for the digestion. The Chilean textbook is intended for slightly younger students. In this case, the series of pictures start with an everyday, concrete photograph (a boy eating an apple) and move towards more abstract representations (a drawn image of the cell). The Singaporean textbook, on the other hand, shows a less concrete image of a body (presented in a kind of x-ray fashion), and this image is supplemented with a zoom-in which gives a schematic image of the walls in the small intestine and a blood vessel, where "small molecules can pass". This zoom-in, in its turn, is supplemented with a schematic image of the cells. The series of pictures with gradually more abstract content in the Chilean textbook could be an attempt to "lead the reader by the hand" towards the representation of the cell, which is quite distant from ones self-conception of "body parts", while the Singaporean textbook put higher demands on the readers' capacity of abstract understanding already from the start.

With regard to images presenting content that is also mentioned in a verbal text, various ways of connecting for instance terminology to an image can be used to facilitate the meaning making for the reader. One such thing is to secure *spatial proximity* between a term and the equivalent part of picture, that is, to give verbal comments to the image within relatively close distance to it. In **Figure 7**, presenting an image from a popular science magazine, proximity is further enhanced by the use of colours. Commonly, arrows or lines between verbal text and image are used when labelling important parts of an image (e.g. upper right of large spread in **Figure 1**).

Another important aspect concerns consistency in terminology use between different representations. The use of terminology shown on the page in bottom image **Figure 1** is consistent throughout the page to the left in the large spread, with specific words like "cell membrane" re-occurring in the visualisation as well as in the verbal text integrated in the visualisation and in the text presented at other parts of the page. However, a closer inspection of "the cell" in **Figure 1** and **Figure 3** reveals that this concept is depicted quite differently depending on what aspects of the cell are highlighted in the different sections. This is something which might need to be pointed out in the educational context, and discussions around the different choices can scaffold both subject content knowledge and multimodal literacy among the students.

Figurative language

There are several reasons to focus on figurative language such as metaphors in relation to multimodality (see Endnote ii, for a note on the use of *metaphor* in this article). First, a metaphor in itself can be seen as a *multimodal ensemble* (e.g. Jewitt, 2009). An example is the use of the metaphor "flow of money" to talk about economic systems. Here the words can lead to a mental visualisation of a flow. Second, metaphors can be expressed through different semiotic modes in a text (writing, image, etc.). Also, the use of metaphors can be related to the content of a knowledge domain (see below) and, consequently, central for meaning making in that area.

In the following, we discuss figurative language in writing as well as in images, since images in pedagogic texts frequently appear as metaphors. One such example is the

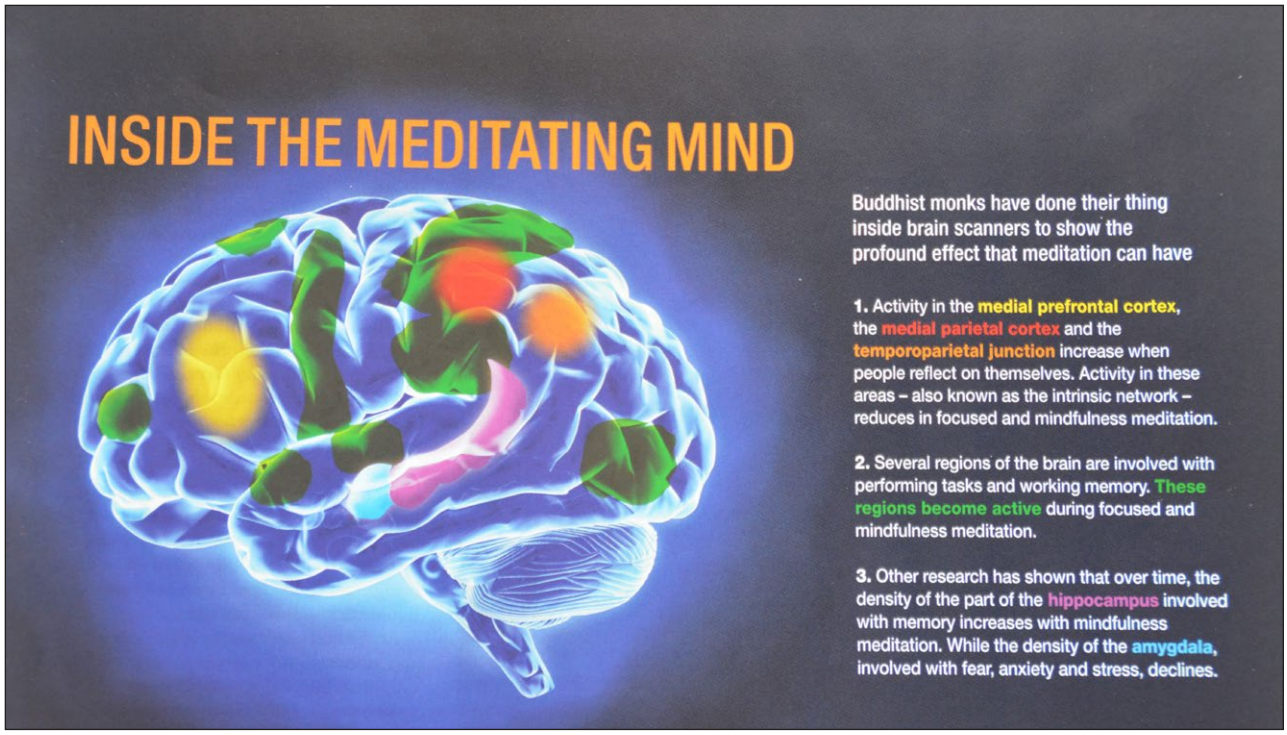


Figure 7: Enhancing proximity by use of colour (Ridgway, 2013, p. 71).

welfare system of a society, where an image could be in the form of water flowing in pipes with the different parts inter-connected as in a technical system.

Figurative language is a natural part of the disciplinary discourse in many areas (e.g. 'money flow' or 'magnetic fields') and is frequently used as a way of understanding and talking about complex structures or processes. Also, such expressions function as pedagogical tools, for example to make "visible" what is not possible to see directly (like micro-worlds, or rather abstract phenomena as a 'monetary system', or concepts like 'democracy'). To some extent, figurative language can function in the same way as a visual model. By using it, it is possible to make an inner visualisation that summarises the main points. At the same time, a metaphor can also be a simplification and generalisation and it is not always clear how far an analogy or metaphor reaches. For example, it might not be obvious what parts or aspects of the source domain (e.g. the water and pipes) and the target domain (e.g. the welfare system) are actually similar, and what parts/aspects are not. This is especially the case for the "novice" in the field.

Also, as regards second language learners the use of uncommented figurative language can be potentially difficult. This is not the least the fact when everyday expressions are used (which is often the case with metaphors, for instance "muscular bag"). For a student who knows the everyday expression, the figurative use can be misleading. Therefore, an important role of the teacher is to "un-wrap" the figurative language and to help students to focus on the adequate aspects of the expressed content.

In the texts we have chosen, we can find some interesting examples of figurative language. We are told that glands produce "special juices", and that there exist "pancreatic juice", "intestinal juice" as well as "gastric juice" (**Figures 2–5**). The concept "juice" is not explained, neither in relation to the everyday language of juices nor in terms of the different kinds of juices within the different parts of the body.

Other metaphoric expressions in the texts are "muscular tube", "muscular bag" and "wall" (**Figure 2**), or "how food *travels*" (**Figure 2**, our italics) through the body. Also, we learn that "hydrochloric acid [. . .] *helps* the protease to work" and that "Long muscular tubes contracts and relaxes, which mixes intestinal juice and pancreatic juice with food, to *help* digestion" (**Figure 2**, our italics). Apart from being metaphoric expressions, food and muscles also become "humanised" with intentions in these examples.[5]

We can also notice more general concepts like "systems" (for example "systems that form the organism" in **Figure 4**) and "functions", which have connotations to a machine-like mechanism, where every part has been made in relation to every other part to serve an overarching whole. In the Chilean book (**Figure 6**, top right) it is said that systems of digestion, circulation or nerves "together form the organism". The flow chart of the digestive system in **Figure 4** further enhances the notion of a system in a type of visualisation.

An interesting kind of analogy is found in **Figure 3** (left, bottom). Here the students are supposed to perform an experiment with water, cooking oil and dishwashing liquid as an analogy for the digestion process when fats break down in the body. In the activity, it is explicitly mentioned that the cooking oil "plays the role of" (i.e. functions analogous to) the fats in the food, while the dishwashing liquid plays the role of the bile. However, the analogous role (if any) of the water is implicit.

Discussions around the use of figurative language in a text, including "un-wrapping" the metaphors/analogies and their reach can function as excellent opportunities for in depth discussions on content matters.

Values

Value statements are part of human communication. Sometimes values are openly declared, and we can simply agree or disagree with them. But equally important are the more implicit or tacit values in a text. In these cases, we need to scrutinise the ways in which the information is presented, and what kind of information is left aside.

In the two texts we analyse here, explicit articulations of values are not frequently used. But one example can be found in **Figure 3** (right) under the sub-heading "Think and explore". The text states that "Some teenagers become obsessed with losing weight [. . .]" and then follows a warning concerning possible dangerous consequences like eating disorders (anorexia and bulimia), which might cause "life threatening conditions" such as "muscle weakness, kidney damage, heart failure and even death if left untreated".

Implicit values are of course more difficult to detect, since they very much depend on the perspective from which the text is interpreted. Here we would like to point out some interesting examples. In curriculum documents, historical links in different content areas are often explicitly stated, though exactly what historical links are supposed to be offered might not always be stated. In the Singaporean text a historical connection is made through some information about Dr William Beaumant, here highlighting his efforts and curiosity, while the fact that he used a live person for his experiments is not problematised (**Figure 2** right). Another example of implicit values is the conceptual hierarchy (**Figure 4**, right), which shows how different concepts are interrelated and, implicitly, how scientific conceptualisations should be organised in more or less general terms. In this case, the text shows us what kinds of representations are valued in scientific work. The hierarchy is also a way of pointing out the role of scientific concepts in relation to the everyday use of different terms.

It is important for students to become aware of the ways in which values can be more or less hidden, in order to prevent them from being manipulated by texts. Also, by highlighting such aspects of texts, interesting discussions connecting to the students' own life experiences can be made possible.

Conclusion

The aim of this article has been to highlight the value of multimodal text analysis and meta-textual discussions in relation to teaching and learning in subject-specific domains, and we have presented a model that can be used as a tool for teachers' and students' mutual text work. The focus in this article has been on printed text and textbooks in the science area, but the same model has been used for texts in all subject domains (Danielsson & Selander, 2014), and it may also be used in the analysis of, for example, digital texts and films.

With our model we highlight and combine three different aspects on text work in educational settings. First we claim that multimodal texts need a *multimodal approach*. This may sound self-evident, but it is not easy to embrace without serious reflection. The long and strong tradition of printed verbal texts viewed as the most important way to deal with knowledge and learning makes it difficult to perceive the multimodal text as something else than verbal texts with additional illustrations. In our work, our point of departure is social semiotic, multimodal analysis (Kress & van Leeuwen, 2006; Jewitt, 2009), where all different semiotic resources, and their orchestration, are analysed in relation to meaning making in different situations.

Second, from the starting point above, we want to relate the multimodal analysis to existing fields of knowledge, or disciplines. This means that we have to relate the multimodal analysis to the *content aspects* of different educational settings, not only the textual expressions as such, or how the reader is addressed (Danielsson & Selander, 2014, also see Unsworth, 2007). In the present article we have used examples from textbooks in natural sciences. However, by using the model in relation to various disciplines, it becomes clear for the user that different disciplines use different semiotic resources differently (see Danielsson & Selander, 2014, for examples). Also, depending on the area of knowledge, different aspects of the model are more important than others to focus on.

Third, meaning making and learning are always socially embedded and related to institutional framings. Not the least learning in a school context is dependent on *cultures of recognition*, that is, how learning is assessed and valued in the school context (Kress & Selander, 2012). This also has a strong influence on the young learners' ways of approaching texts in educational settings. Therefore, we also highlight how to work with multimodal texts in the classroom to help students "reading" the text both as a multimodal text and as subject oriented content. Here, the more used to meta-textual discussions the students become, the more active they could become in the discussions.[6] For older students, and for students that have become used to scrutinising texts, quite advanced analyses can be done. For younger students, or students with only little previous experience of meta-textual focus, the teacher might primarily function as a "guide". For older and more experienced students the teacher could leave more space for students to interact with each other to unfold different aspects of a text, and then arrange for joint discussions of how different semiotic resources express content aspects, values etcetera.

To conclude, in comparison to other more general approaches to reading (e.g. Beck & McKeown, 2006; Palincsar & Brown, 1984), frameworks for enhancing multimodal literacy in a more general sense (e.g. Tan et al., 2010), or frameworks focusing mainly the verbal aspects (i.e. writing and speech) of disciplinary discourse (Christie & Derewianka, 2008; Martin & Rose, 2012), our model highlights mutual *multimodal text analysis in relation to*

the subject content. Thereby we emphasise a *meta-reflective* perspective in the reading of multimodal texts in relation to the ways in which knowledge is represented, which is a crucial aspect of learning.

The model is intended for different subject areas, and as was discussed above, different disciplines place different multimodal demands on the reader. This becomes evident in the book in which we present the model more thoroughly (Danielsson & Selander, 2014)[7].

Competing Interests

The authors declare that they have no competing interests.

Notes

[1] In our Swedish model (Danielsson & Selander 2014), we use an equvialent to 'written verbal language' (Sw. 'skrivet verbalspråk') for the part of a text which is expressed in written words, to emphasise the fact that we treat, for instance, mathematical symbols and 'written verbal language' as different *semiotic modes* (e.g. Kress 2010). In English, 'verbal language' appears to have a strong connotation towards spoken words. Therefore, in line with, for instance, Kress (2010), we use "writing" in this article.

[2] Research and theory around metaphors and analogies is vast (one key volume is Lakoff & Johnson, 1980) and there are several ways of defining these terms, though all definitions include a possibility of activating two distinct domains. In line with Cameron (2002), we here include similes and analogies in *metaphor*, and we also include other means of representation than linguistic expressions.

[3] *Multimodal Analysis Image* (Tan et al. 2012) has been used in exploratory studies in Singaporean schools (Lim & O'Halloran, submitted, Lim et al. 2014). However, rather than focusing on content and multimodality, the main intent in these studies has been to cultivate students' multimodal and critical literacy, for example by letting students analyse and create multimodal texts in relation to advertisements (Lim et al. 2014).

[4] An English version of the book, including a thorough presentation of the model along with numerous text examples will be published by Springer.

[5] This is also discussed by Danielsson, Löfgren, and Pettersson (accepted), who noted an extensive use of such anthropomorphic metaphors in chemistry texts and classroom discourse.

[6] This also relates to a more general view of metacognitive skills (e.g. Mevarech & Kramarski 2014).

[7] Apart from giving a more comprehensive background to the model, we devote half of the book to analyses of pedagogic texts from different content areas and in different media.

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