# Dual Coding and Education


## Abstract

Teachers and academics are becoming increasingly interested in the application of cognitive science to education, as they work to make sure learning is the most effective it can be. Dual coding is a theory that is widely used in a classroom setting and has a significant literature base to support it. However, the theory is often defined unclearly, which can lead to it being used ineffectively. This article defines dual coding and explores its academic basis, as well as its application to a classroom environment. There is a particular focus on argument mapping, which uses dual coding to display arguments.


## Defining Dual Coding

This article discusses the theory of **dual coding**, which is a useful concept for educators. **Cognitive load** theory is referenced throughout, so if you are unfamiliar with the term or need a reminder, click here to read our article on optimising cognitive load theory in education.

Dual coding theory claims that we process **verbal** and **non-verbal** information separately – there are "distinct verbal and nonverbal cognitive systems" (Clark and Paivio, 1991). The verbal system is made up of units called **logogens**, while the non-verbal system is made up of **imagens** (Sadoski and Paivio, 2004). Dual coding is the conveying of information using verbal and non-verbal means together.

| System | | Verbal | Non-verbal |
|---|---|---|---|
| Unit | | Logogens | Imagens |
| Examples from different sensory modalities | Visual | Written words, e.g.<br><br>*It was a sunny day.* | An image of the sun, e.g.<br><br>  |
| | Auditory | Spoken words | The noise of a crowd |
| | Haptic | Braille | The "feel" of an object |

*Table 1: The characteristics of the verbal and non-verbal cognitive systems. Based on Clark and Paivio (1991) and Sadoski and Paivio (2004).*

An important distinction to make is that dual coding is not a matter of using two different senses. Conveying information via written words and pictures is dual coding, because one is verbal and the other is non-verbal, even though both use vision. But using spoken words and written words together is not dual coding because they are both types of verbal information, even though they use different senses: vision and hearing. Hence, dual coding has nothing to do with the (discredited) idea of 'learning styles'. Also, note that the sound of a noisy crowd is an example of non-verbal information (Table 1) because, although people in the crowd may be speaking, the unintelligible noise of many people speaking at once is not *language* with a particular meaning.

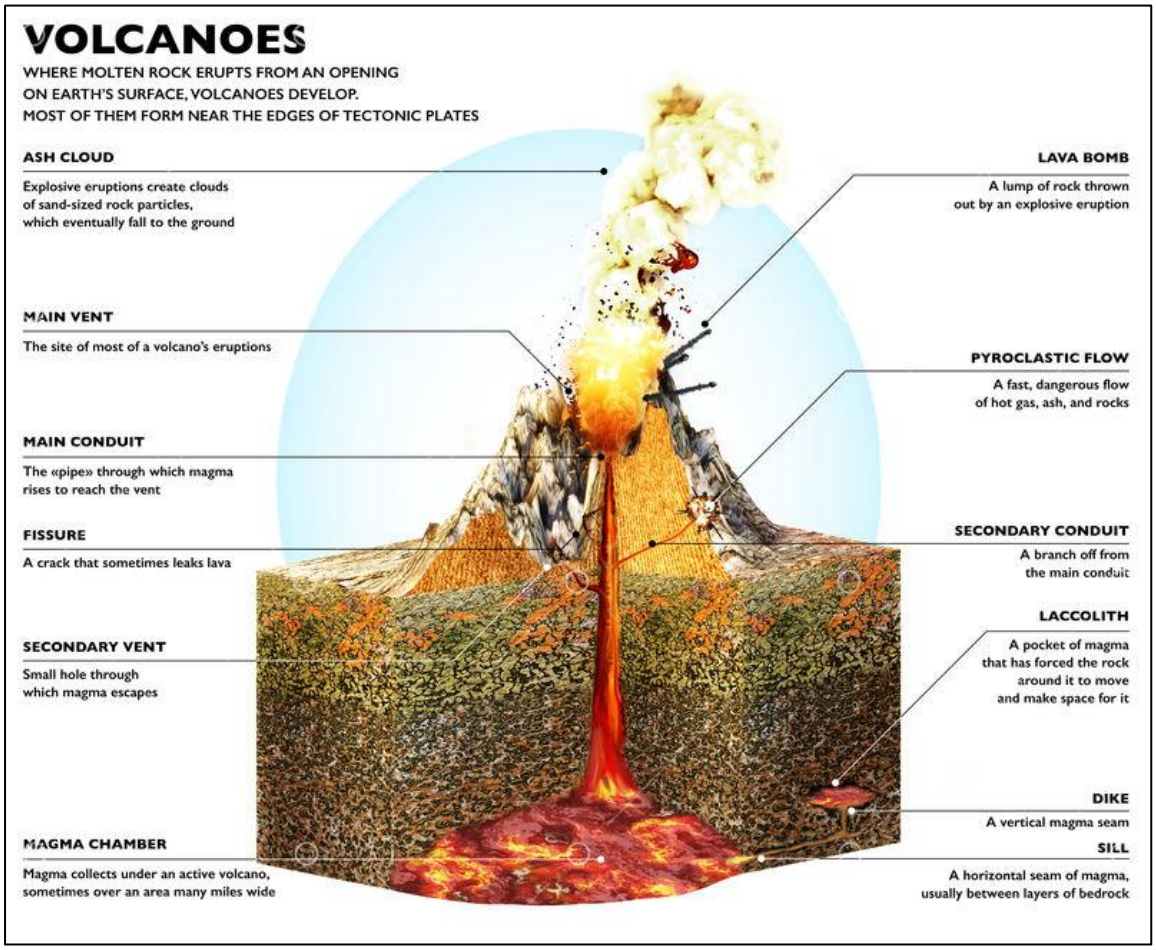


*Figure 1: A diagram of a volcano (vampy1, 2022).*

Dual coding is most commonly used in learning by displaying textual information alongside images, which is an easy and effective way of using this method. For example, Figure 1 shows an image of a volcano, with text used to identify and describe its

component parts. By dual coding the information, the diagram makes it easier to understand the structure of the volcano.

## Dual Coding with Graphic Organisers

*In 1509, the newly-crowned King Henry VIII married Catherine of Aragon. They were married until 1533, when the Queen's failure to produce a male heir led the king to find a new wife. He divorced Queen Catherine and married Anne Boleyn in the same year. Like Catherine, Anne gave the king a daughter but no sons and their marriage ended in 1536, when he had her beheaded. Once again, the king quickly remarried. His new wife, Jane Seymour, gave birth to a baby boy in 1537 but died two weeks later. King Henry would later be buried with Jane Seymour after his death in 1547. In 1540, three years after the death of his third wife, the king married Anne of Cleves. However, the marriage was quickly annulled after the king claimed that she was too ugly. He then married Catherine Howard, but this marriage ended in another beheading in 1542. Henry married his final wife, Catherine Parr, in 1543 and remained with her until his death, which followed years of illness.*

*Figure 2: Information about the wives of Henry VIII, written in prose.*

The concept of dual coding can apply to different types of non-verbal imagery. Figure 2 is an example of information written in prose, without dual coding. How easy is it to work out the chronological order of Henry VIII's marriages from this text?

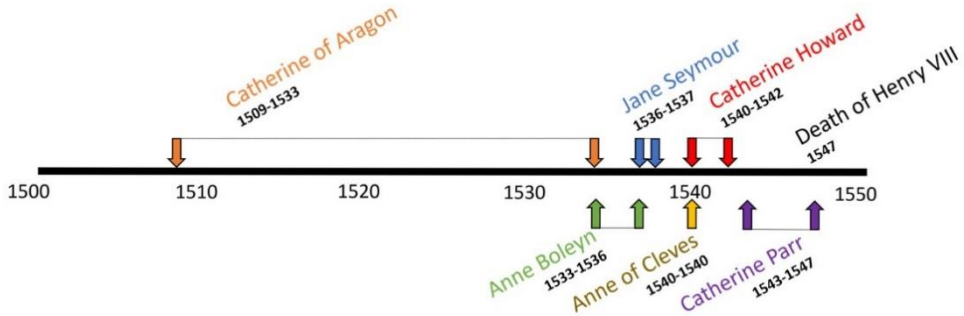


*Figure 3: Information about the wives of Henry VIII, visualised using a graphic organiser.*

Figure 3 presents this information in the form of a **graphic organiser**. A graphic organiser is a diagram that visualises relationships between facts, concepts. Here, the names of Henry VIII's wives and the lengths of his marriages are displayed on a timeline. This familiar form of graphic organiser uses space to quickly convey dates and lengths of time.

In doing so, it makes it much easier to work out the chronological order and duration of Henry VIII's marriages. The important information from Figure 2 has been dual coded, with the timescales displayed *non-verbally* to make them easier to understand.

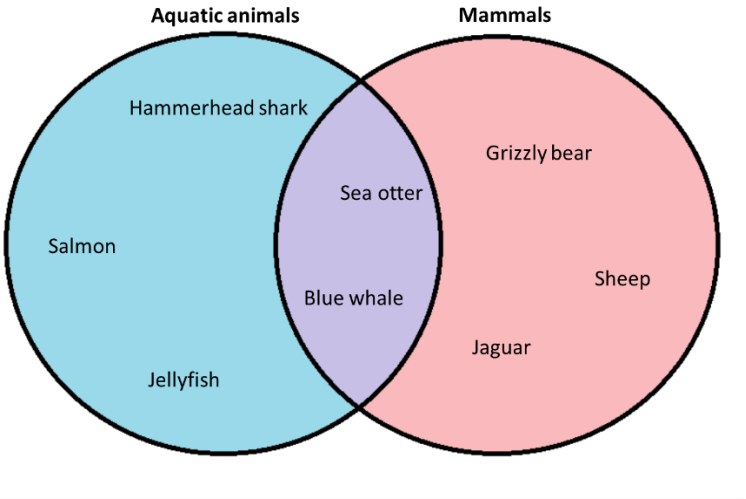


*Figure 4: A Venn diagram classifying animal species based on whether they are aquatic, mammals, or both.*

Venn diagrams are another well-known form of graphic organiser. Figure 4 shows the names of the animals *verbally* and the characteristics of these species *non-verbally* by grouping them into different parts of the diagram.

## Why is Dual Coding Important?

In a previous article, we discussed **cognitive load theory** and the idea that a student's (or indeed anyone's) working memory is limited, while their long-term memory is practically unlimited. If the **cognitive load** is too high, students will not be able to hold it all in their working memory. As a result, they will struggle to learn new information by transferring it to their long-term memory (Sweller, 1988). So, to help students learn we need to try to minimise cognitive load. We can use dual coding to do this, because of the fact that verbal information is processed in a different way to non-verbal information. By presenting new information both verbally and non-verbally, we can "access more working memory capacity": the verbal memory capacity *and* the non-verbal memory capacity (Kirschner, 2019).

Caviglioli (2019), a well-known proponent of dual coding in education, argues that four principles are essential to the successful design of dual-coded resources (Table 2). All of these principles relate to making information easier to understand and learn.

| Cut | Chunk | Align | Restrain |
|---|---|---|---|
| Only include important information. "Cut" the rest. | Group related pieces of information into clear "chunks". | "Align" chunks of information to make it easy read. | "Restrain" your use of design and colours – keep it simple. |

*Table 2: Caviglioli's (2019) "design guide" for dual-coding.*

## Dual Coding and Argument Mapping

Our previous article on cognitive load theory highlighted the benefits of argument mapping, based on the reduced cognitive load compared to argumentative text that is written as prose. But how does this relate to **dual coding theory**?

Argument mapping uses a combination of simple statements and symbols such boxes and arrows to display an argument as a diagram. This is a clear form of dual-coding. In the case of argument mapping, the statements are the **verbal** components, while the boxes and arrows are **non-verbal**. The boxes contain the statements and the arrows show a relationship between different statements, which help to build the argument toward its conclusion.

At Endoxa Learning, we use the principles of argument mapping to create diagrams of academic arguments called 'argument graphs'. Let's take a look at an example of how verbal and non-verbal information is combined in an argument graph.

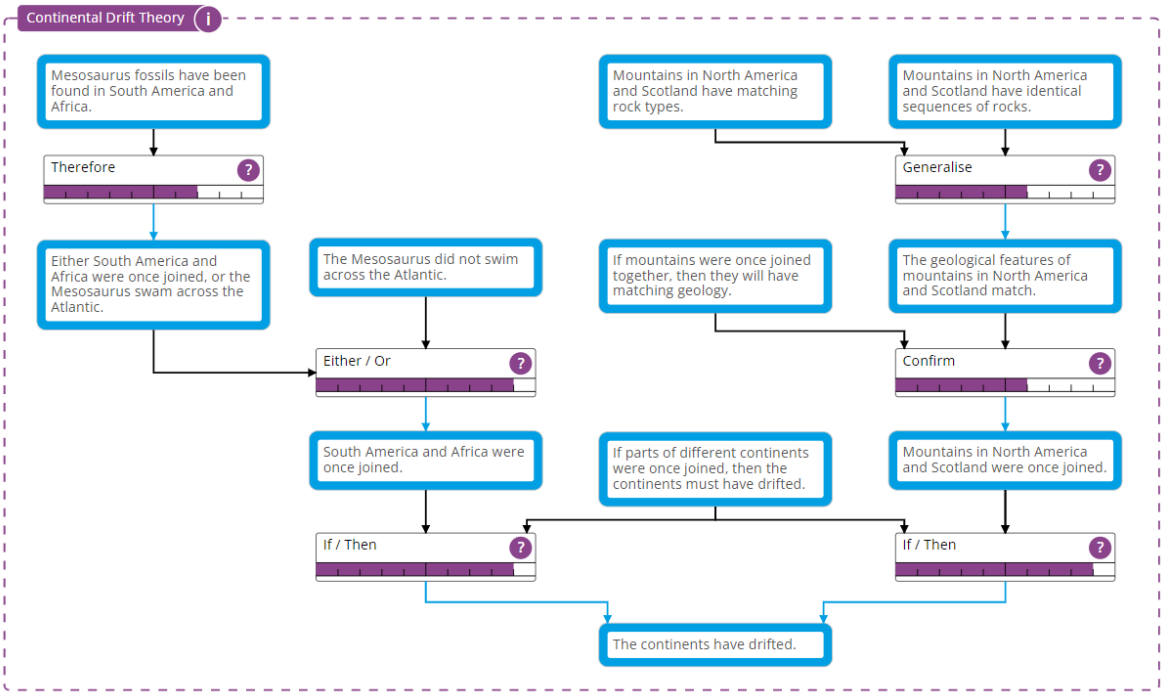


*Figure 5: An argument graph about continental drift theory. The graph is made up of two different branches: the first branch discusses fossil evidence; the second, geological evidence.*

Compared to an original source comprising paragraphs of argumentative text, an argument graph from Endoxa Learning uses dual coding to make it easier to learn (Figure 5). The main verbal components are the statements which participate in the argument, e.g. "the Mesosaurus did not swim across the Atlantic" Any other text which might be present in the original text is discarded or relegated to annotated notes. **Argument type** labels can also be used to help students understand how each step of the argument works, such as "because" or "either/or".

The non-verbal components are the boxes, the arrows and the overall layout. The boxes use colour to show whether statements are true or false. The argument itself is displayed visually, by using the boxes and the arrows that connect them. The arrows represent logical relations between the different statements, connecting premises with a conclusion and one step of the argument to the next. The overall layout of the argument graph shows the branched structure of the argument graph, with the two branches flowing to the final conclusion, "*the continents have drifted*".

Each of Caviglioli's (2019) design principles are evident: Only essential information is included; sections of the argument are grouped into chunks; the different chunks are aligned to make it easier to read; and the design is simple, without too much colour.

## The Benefits of an Argument Graph

Making the structure of arguments explicit is useful and important, because when arguments are written as prose, students do not recognise arguments in text (Dwyer et al., 2012). Instead, they read the text "as if it were a story" (ibid., p. 220). This is because arguments in text are often inexplicit and need to be inferred by the reader. On the other hand, an argument graph makes the flow of an argument explicit through the use of symbols and colours. As a result, students no longer need to work out how each statement is connected, because these relationships are "explicit" (van Gelder, 2003; Davies et al., 2021). This means that the student can learn the argument more easily. Most importantly, it means the student can see how a good argument is constructed and will be able to apply the same rules to their own work, avoiding unimportant information and poor structures.

Furthermore, the improvement of critical thinking skills is at the heart of Endoxa Learning; Dwyer et al. (2012) found that these skills are improved when students used argument mapping. Davies et al. (2021) argue that two principles underpin the theory that argument mapping improves critical thinking[1]. The first of these principles states that dual coding through the use of words and diagrams causes "better cognitive processing of complex information" (ibid., p. 118). The second principle is linked, arguing that we can take in "complex arguments" more effectively if some of the information is in a diagrammatic format. Essentially, the benefits of dual coding apply to learning arguments, so if we display arguments using a combination of text and diagrams, students will be able to understand and learn those arguments more effectively. In turn, we argue that this helps them to think critically and construct their own well-reasoned arguments.

Click here to read more about how our argument graphs work.

Rosie Brown *Content Creation Leader*

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## Notes

[1] Critical thinking can be defined as "reasonable, reflective thinking that is focused on deciding what to believe or what to do" (Ennis, 1989, p. 4).

## References


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