**Four Multiplicative Connections**

**Connections 2**

**Connections 3**

**Connections 1**

**Connections 4**

**Arrays**

**We contend that multiplicative thinking is characterised by four sets of conceptual connections, all of which overlap to varying degrees with at least one other set of connections. Each set of connections is based on the multiplicative array which can be used to conceptually explain elements of the connection sets and the links between them. This is represented in the above graphic. The following graphic provides details of what actually comprise the four connection sets, whilst still showing the inter-linking between the sets.**



**Connections 1**



**Connections 2**



**Connections 3**



**Connections 4**

**Multiplicative Connections**

***Is there a hierarchy?***

**How hierarchical are Connections 1, 2, 3, and 4? . . . probably quite a bit!**

**Connections 1 is highly foundational in that, unless the language of factors and multiples, the inverse relationship between multiplication and division, equal groups, arrays, and commutativity are *well* understood as being connected, there is little likelihood of children grasping the ‘times as many’ concept in Connections 2.**

**Connections 2 highlights the importance of understanding place value. Unless that understanding is solid, the ideas of digit movement across the places, the ‘times as many’ concept, and extended number facts are unlikely to be understood. Some of the ideas in Connections 2 are going to be challenging for younger children but they need to know them at a foundational level. That is, ideas like 1.6 × 10 and 16 × 0.1 would be beyond most children at Year 3 or 4, but they need to understand the fundamentals of digit movement and extended facts, such as knowing that the product of 70 × 4 will be ten times as many as the product of 7 × 4 because one of the factors has been increased by a power of ten.**

**Connections 3 involves the development of an understanding of the algorithms for multiplication and division. These are not likely to be needed until Year 5 but children need to know what underpins them and to apply that understanding to mental computation. That is, they may not be calculating products like 38 × 46 but they ought to be able to apply place value partitioning and the distributive property to mentally calculate the product of say, 18 × 7 by doing (10 × 7) + (8 × 7).**

**Connections 4 involves proportional reasoning, ratio, fraction, and percentages. Elements of Connections 4 develop early alongside the other connections (e.g., when a whole is divided into parts, the parts are equal) but the majority of concepts in Connections 4 are not fully developed until late in primary school, or in middle school.**

**So, how might this hierarchy be represented?**

**Connections 1**

**(mostly by the end of Year 4)**

**Connections 2**

**(mostly by the end of Year 5)**

**Connections 3**

**(mostly by the end of Year 6)**

**Connections 4**

**(mostly by the end of Year 7)**

**This graphic depicting the connections as ellipses attempts to show how the four connections sets develop simultaneously, rather than in a linear fashion. The ellipses are purposefully drawn as ‘wrapping around’ one another to emphasise that while Connections 1 is perhaps more foundational than the other sets, Connections 2, 3, and 4 are developing alongside Connections 1. Indeed, teachers can be working on any of the connections at any time. That is, some work could be done on the inverse relationship (Connections 1) whilst developing the related notions of digit movement, times as many, and extended number facts (Connections 2), as well as the properties of multiplication (Connections 3) and early fraction understandings (Connections 4).**