Handout 10.2: Ensuring pupils have relevant domain-specific knowledge, especially when being asked to think critically within a subject

Read the following excerpt adapted from Sweller, J., van Merrienboer, J. J. G. & Paas, F. G. W. C. (1998) Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251–296. https://doi.org/10.1023/A:1022193728205/.

Why should expert chess players be superior at reproducing board configurations taken from real games but not random configurations? Grand masters have spent many years of practice attaining their high level of expertise.

Grand masters can easily and accurately reproduce configurations taken from real games because each configuration is one with which they are familiar, but they are no better than anybody else at reproducing random configurations with which they are unfamiliar.

Skilled chess players recognize most of the board configurations they encounter, and they have learned the basic move associated with each configuration. Unlike less-skilled players, they do not have to search for good moves using limited working memory.

Similar findings were obtained in a variety of domains during the late 1970s and early 1980s (e.g., Barfield, 1986; Egan and Schwartz, 1979; Jeffries, Turner, Poison, and Atwood, 1981; Sweller and Cooper, 1985). **All studies confirmed that the major factor distinguishing novice from expert problem solvers was not knowledge of sophisticated, general problem-solving strategies but, rather, knowledge of an enormous number of problem states and their associated moves.**

The human cognitive system can be characterized as one that places its primary emphasis on the ability to store seemingly unlimited amounts of information in long-term memory. This information does not just consist of small, isolated facts but can include large, complex interactions and procedures. From this view, human intellectual prowess comes from this stored knowledge, not from an ability to engage in long, complex chains of reasoning in working memory.

Indeed, knowledge about working memory limitations suggest humans are particularly poor at complex reasoning unless most of the elements with which we reason have previously been stored in long-term memory. Working memory simply is incapable of highly complex interactions using novel (i.e., not previously stored in long-term memory) elements.

It follows that instructional designs and instructional recommendations that require learners to engage in complex reasoning processes involving combinations of unfamiliar elements are likely to be deficient. Human working memory does not support such activity. Chess grand masters are successful, not because they engage in more sophisticated reasoning procedures than weekend players, but because they have access to knowledge unavailable to others. If anything, it is the less expert players who must engage in complex chains of reasoning but, of course, these are likely to overburden working memory. Novice players must engage in such reasoning, not because it is particularly effective but rather, because they do not have access to knowledge that is effective. When translated to the field of instructional design, it follows that instruction should facilitate **domain specific knowledge acquisition**, not very general reasoning strategies that cannot possibly be supported by human cognitive architecture.