THEORY GUIDE

Concept: **Cognitive load theory**

Brief overview of concept:

Cognitive load theory (CLT) has its basis in the evolution of human cognition, and the processing of knowledge and memory within the brain (Sweller, 2010, 2011). CLT defines two layers of biologically-derived knowledge – **biologically-primary** knowledge (the knowledge we need to survive as organisms) and **biologically-secondary** knowledge (culturally-important knowledge, learned as a part of society, and which is not necessarily directly related to survival). Biologically-primary knowledge includes core skills learned at an early age, such as speaking, use of language, problem-solving, performing basic skills, recognising helpful and harmful things, as well as recognising people. Biologically-secondary knowledge includes more abstract or non-essential knowledge, such as mathematics, science, music, literature, cultural idioms and practices, skills that are not essential, and which require active thinking to undertake.

Cognitive capacity and memory can be divided broadly into two areas: **Working memory** and **long-term memory**. Working memory is where immediate information is stored, information that is used in active thinking processes. Learning is processed by working memory, until it is then stored in the long term memory. The work of Miller (1956) suggested that working memory is limited to the number of different concepts or categories (the cognitive load) that it can hold at any given time. Miller suggested that for most people, that number was "seven, plus or minus two". Overload of the working memory by increased cognitive load therefore means that the ability to process all of that information is limited. Working memory is also limited in its duration, as well. Long term memory potentially has neither of these limitations. The processing of working memory into long-term memory requires the learner to have strategies or 'schemas' to efficiently store that information in a way that enables retrieval of it. Repeated 'retrieval practice', whereby that long-term memory is recalled and reused, reinforces those retrieval processes and makes the long term memory more readily-accessible.

The brain therefore has only so much working capacity or **working memory**, which needs to cover a range of activities at any given time. The impact of this for learning and education is substantial, since if the cognitive load on the brain is too great, and/or thinking processes are being sequestered by unnecessary distractions, then the learning opportunities are going to be minimal (Sweller, 2011; Barnett and Ceci, 2002). Biologically-primary knowledge requires very little cognitive load, as it is typically relating to skills we can do subconsciously or with minimal effort. Biologically-secondary knowledge requires much greater cognitive load, as it usually requires a degree of concentration and active decision-making or recall. This distinction is important for education, and especially assessment, as most educational and assessment activities will be primarily based on biologically-secondary knowledge.

Cognitive load itself can also be subdivided into categories. There are three types of cognitive load that impact upon learning (Sweller, 2010).

Intrinsic load is related to the material being learned. The more complex the material, the greater the intrinsic load. It is important to note that intrinsic load is highly individualistic. A learner with an aptitude for a particular subject will experience less intrinsic load than a peer who struggles in that subject, even if the material is the same.

Extrinsic load is related to the way in which the information is presented to the learner. Amaterial presented in a confusing or opaque manner will have a greater extrinsic load than material explained clearly, with the use of visual or auditory aids to support the explanation. Again, extrinsic load is highly personal, as one means of explanation may make sense to one learner, but be confusing for another.

Germaine load refers to the activity required to convert the information from working memory into longer-term memory (Debue and van de Leemput, 2014). Germaine load is helped by schemas or cognitive strategies that an individual learner might have adopted. It is also impacted by personal factors such as interest, motivation, and personal goals.

The key challenge highlighted by CLT is that learning is likely to occur if the cognitive load is eased, and the intrinsic, extrinsic and germaine loads are minimised by clear, straightforward, and adroit teaching, which supports the development of learning strategies and schema in the learner. These principles align very strongly with the EAT framework, which focuses very much on the provision of clear, focused, and student-centred support for assessment.

The **Assessment Literacy** subdimensions all aim to empowering the student to understand the potential of assessment for their learning and development. By supporting the student to internalise standards (AL1) as well as see how the assessment fits in with other assessments (AL2) and the overall requirements of the discipline (AL4), extrinsic and germaine load are minimised, making the development of effective learning schemas easier. Providing opportunities for retrieval practice of information, through regular formative assessment opportunities, is also important.

Assessment Feedback subdimensions also focus on reducing cognitive load, by ensuring that feedback is accessible (AF1) and provided in a timely manner (AF2), as well as being open to discussion and self-reflection of feedback (AF3 and AF4). These approaches both reduce intrinsic and extrinsic load, and encourage the development of schemas to support the efficient use of working memory. In particular, they reduce germaine load by making it clearer what the learner is expected to glean from the feedback provided, and how to embed that understanding in their long-term memory. Feedback that explains rather than providing the answers is also effective at supporting retrieval schemas from long-term memory (Butler *et al.,* 2013)

Effective **Assessment Design** is absolutely underpinned by CLT. Meaningful and inclusive assessments need to consider the challenges of cognitive load. Meaningful and authentic assessment (AD2) reduces cognitive load by meaning that the student does not have to develop a new, and potentially irrelevant, skill, just in order to undertake the assessment. Instead, they undertake an activity which is also relevant to their professional development. Considering inclusive assessment practices means that students with specific learning needs do not also have to deal with the cognitive load caused by an assessment method, or exclusionary guidelines. Finally, ensuring that the student understands the whole assessment process (AD1) and has a chance to be involved in its quality enhancement (AD4) means that the cognitive load caused by uncertainty about the assessment process is also minimised.

Consideration of CLT is also important when supporting students in their development of self-regulated learning strategies.

A key challenge for the designers of assessments is therefore to consider the potential impact of cognitive load on the students undertaking those assessments. This will impact on:

- Assessment format or modality (does the activity in the assessment induce unnecessary cognitive load?);
- Assessment timing (is it conflicting with other distractions for the student?);
- Assessment environment (are there distractions or other extrinsic factors?);
- Assessment guidelines (are the criteria and guidelines clear and unambiguous, so the student does not face extrinsic cognitive load to understand them?);
- Assessment focus (is the material relevant to the overall learning journey?);
- Authenticity and meaningfulness (is the assessment supporting the development of a professional skill, or a skill they will use after graduation?);
- Inclusivity and equity of the assessment.

For further reading, Likourezos (2021) is a clear accessible summary of CLT. Also, Friedlander *et al.* (2011) evaluates teaching and assessment practices from a cognitive neuroscience perspective. Schneider and Preckel (2017) is also very useful. See also the EAT-Erasmus Self-Regulation Report (https://www.eat-erasmus.org/selfregulatedassessment)

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