Improving Literacy Outcomes for Students with Reading Difficulties in Post Primary Schools: Supporting Executive Skills for Reading Comprehension

Introduction

Comprehension of text is the ultimate goal of reading, and comprehension difficulties can have important consequences that affect not only school achievement but life opportunities (Cutting et al., 2009). Lack of decoding skills, word recognition and reading fluency impedes successful reading comprehension (Oakhill & Cain, 2012; Pikulski & Chard, 2005). However, comprehension is also supported by top-down skills such as those that come under the rubric of executive functions (Meltzer, 2010; Moran & Gardner, 2007). Executive functions are a group of higher order cognitive skills that control and regulate behaviour. They involve goal-related tasks. They enable us to pause to think before we act, resist temptations, stay focused, deal with unanticipated challenges, and resist impulsivity (Jurado & Rosselli, 2007). This paper will explain what executive skills are and how they influence text comprehension. It will also describe some key strategies that are supportive of executive functions for reading comprehension.

What are Executive Functions?

Executive functions (EFs, also called executive control, cognitive control, or executive attention) refer to a class of higher-order cognitive or mental processes that require an individual to concentrate and pay attention in situations as opposed to being instinctive and using intuition (Diamond, 2013; Stuss & Alexander, 2000). These processes include higher order skills such as working memory, inhibition (of irrelevant information), self-monitoring, shifting attention, and cognitive flexibility (Anderson, Northam, Hendy & Wrenall, 2001), as well as goal-directed behaviour such as goal formation, goal planning, carrying out goal-directed plans, and effective performance on tasks (Lezak, 1983).

Although the concept of executive function is accepted and supported by scientific literature, its components are not clearly defined, and there are several differing definitions of executive functions. Denckla (1996) describes EF as the ability to plan and sequence complex behaviour and simultaneously attend to multiple sources of information. This definition also includes the ability to grasp the gist of complex situations, to resist distraction and interference, to inhibit inappropriate responses, and to sustain behaviour for long periods of time. It is known that executive processes involve attentional components such as the ability

to focus, divide attention, and switch attention from one thing to another (Baddeley, 1992). EF is thought to facilitate the development of efficient, automatic processing of information (Swanson, 2006) which is a particularly important process for skillful reading.

Unity vs Componential Views of Executive Functions

There is an ongoing question as to whether executive functioning can be conceptualised as one single underlying ability that can explain all its components (theory of unity), or whether these components constitute related but distinct processes (non-unity). There is research evidence for both. Evidence for unity theory suggest that there is a common mechanism or unifying factor such as WM or general intelligence underlying EF and the organisation of goal-related behaviour (DeFrias, Dixon & Strauss, 2006). For example, the idea of the 'central executive' in the Baddeley and Hitch (1974) model of working memory has prompted the understanding of a unitary concept of executive functions.

However, others question the existence of one unitary factor related to all measures of EF. It is argued that, as the development of EFs is not linear but dynamic (Fischer & Daley, 2007), this term is misleading. The componential view is also supported by evidence of a highly consistent pattern across studies showing that the intercorrelation between executive tasks often lacks statistical significance (Miyike et al., 2000; Salthouse, Atkinson & Berish, 2003). Low correlations can be due to the influence of non executive processes or to variables that reflect different types of executive processes rather than one unitary construct. Miyike et al. (2000) studied three aspects of EF (inhibition, updating and shifting) and found that, although they are distinguishable, they do share some underlying commonalities. Thus executive functions are most often conceptualised as separable but moderately related constructs, suggesting both unitary and non-unitary components of the executive system (Miyike et al., 2000). Despite the lack of clarity it is generally agreed that there are three core EFs: inhibition (inhibitory control, including self control), working memory, and cognitive flexibility (also called set shifting or mental flexibility) (Diamond, 2013).

Inhibition

In order to engage in conscious, reflective problem solving, one first needs to inhibit dominant or automatic responses that are not relevant to the situation presented. Inhibition is defined as the ability to delay or suppress a prepotent (automatic or overlearned) response in order to achieve a goal, and it protects that delay even in the face of interference or distraction of any kind (Miyake et al., 2000). Inhibition is related to information processing

as it involves the ability to ignore irrelevant information and focus on the relevant (Denckla, 1996), and it supports other executive skills such as set shifting which involves changing one's attentional focus from an initial idea to a new one. When automatic responses are inhibited, self-regulatory actions are then implemented. In addition, when certain information is voluntarily ignored in order to attend to goal-based information, this is called controlled attention. Self-control is the aspect of inhibitory control that allows us to control our behaviour, so that we do not act impulsively (Barkley, 1996). *Inhibition* supports children in forming good text representations. During reading, irrelevant and distracting information encountered needs to be suppressed in order to form accurate and logical representations (Cain, 2006; Carretti et al., 2009). Maintaining attention on the construction of meaning for the duration of the reading process involves inhibition .Importantly, inhibition first begins to develop around three to four years of age but continues to develop through adulthood (Diamond, 2013).

Cognitive Flexibility and Set-Shifting

These processes involves the ability to consider multiple pieces of information at the same time and switch between them. One aspect of cognitive flexibility is being able to switch or change perspectives from one aspect to another aspect of a task (Cartwright, 2008). This is also called *attentional control***.** To achieve this, one needs to inhibit the previous perspective and activate a new perspective in working memory. In this way, cognitive flexibility builds on both working memory and inhibitory control (Diamond, 2013). In terms of reading, this can mean thinking of the sounds in a word to decode it (and inhibiting other automatic sounds and blends), as well as thinking about the meaning of the text, and switching attention between decoding and reading for meaning. A further dimension of cognitive flexibility is the ability to monitor one's behaviour (Cartwright, 2015). *Monitoring* involves the ability to stop and reflect on one's thoughts and mental processes as well as one's perspective. It is important to monitor meaning as one is reading and this process is closely related to self-regulation (Meltzer, 2007).

Mental set shifting requires the ability to inhibit an activated set of tasks in order to shift to and activate another set. It involves switching attention among stimuli or tasks as task demands change (Denckla, 1996; Miyake et al., 2000), and so, it is likely to involve inhibition and attention-switching activation mechanisms. It is thought to be particularly relevant to perseverative errors, or involuntary errors related to continuing ideas and/or experiences that are no longer relevant. These kinds of errors are caused by an inability to

switch attentional focus from one target to another (Cartwright, 2008). *Planning* which is part of cognitive flexibility, involves the ability to decide which actions are necessary to complete a goal (Cartwright, 2009; Diamond, 2013). Planning has been shown to account for variation in reading comprehension after controlling for decoding, listening comprehension and workiing memory, and as such it is a very important executive process for reading (Cutting et al., 2009; Sesma et al.,2009). It is proposed that good planners regularly monitor whether their text representations are correct and if not, will change strategies in order to achieve a correct understanding of a text (Cartwright, 2015).

Working Memory

Working memory controls attention and action, particularly when performing two or more tasks simultaneously. It involves holding information in mind, and mentally working with other information (Baddeley, 2012). For example, a child with a working memory difficulty would find it difficult to perform two tasks simultaneously, such as trying to remember what has been read, while engaged in decoding. Furthermore, reading requires integrating incoming information with information already read, and with their prior knowledge (Kintsch, 1998). which requires higher-order executive processes (Cutting et al., 2009) which support reading comprehension. In addition, individuals performing tasks that involve working memory must remember some elements of a task, and ignore (inhibit) others as they complete the task. Another important element of working memory is updating of information. This involves the evaluation of incoming information for relevance to the task at hand, and subsequent revision of the information held in memory. This information is then revisited in light of new information (Diamond, 2013).

There are some commonalities between all three functions described above, which are moderately correlated (Miyake et al., 2000) and it is thought that inhibition might be the key factor given that all three processes involve inhibitory processes. For example, updating requires the discarding of irrelevant incoming information and the suppression of obsolete information. Both processes are a form of inhibition. Likewise, shifting requires the deactivation or suppression (i.e., inhibition) of an obsolete mental set in favour of a new one. These three core executive functions enable other important higher-order executive processes to develop such as planning, problem-solving, and reasoning ability (Collins & Koechlin, 2012).

From an educational perspective, executive functions mediate the ability to focus attention and organise our thoughts in a goal-directed way, and, as such, they are essential for success in school and the learning environment. In terms of learning, executive skills have been described in terms of three parameters: "hill, skill, and will" (Moran & Gardner, 2007). *Hill* can be described as the goal or destination of a students abilities and efforts. *Skill* is described as the learned behaviours, skills, and abilities that can be drawn on in the achievement of a goal, and *will* involves the motivation and effort needed to link the skills needed with the goal. What appears to be challenging for many students is the requirement to integrate and co-ordinate the multiple skills involved in these processes for the purposes of learning (Meltzer, 2010). It is argued, therefore, that understanding executive functions as multiple components will help educators develop more focused and differentiated interventions for students with EF difficulties (Moran & Gardner, 2007). Executive processes that affect academic performance are shown in Figure 1. It is important to remember that *attention* is a prerequsite for most of these skills and processes (Thomson et al., 2005).

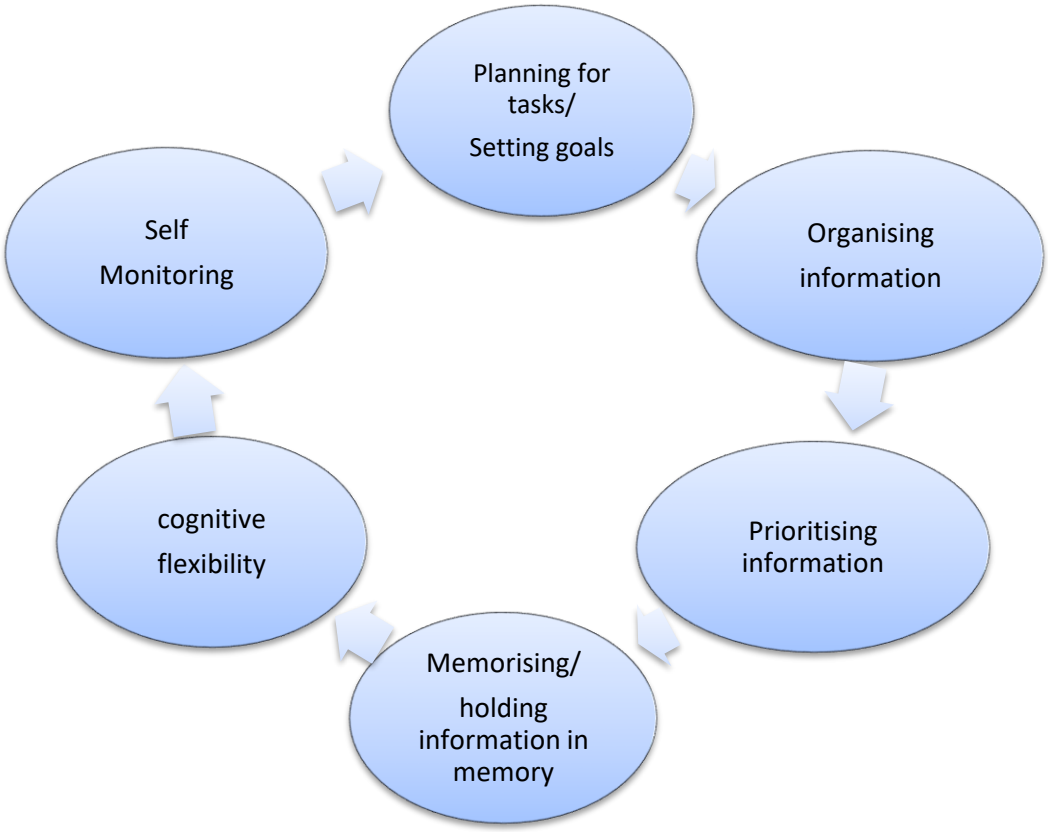

Figure 1 Important Executive Functions for Learning

Executive Functions and Reading Achievement

It is thought that 10-15% of school children have difficulty with reading (Vellutino & Fletcher, 2010). Theoretical accounts of reading difficulty argue that the source of these difficulties is in language-based processes such as phonological processing (Snowling & Melby-Lervag, 2016). However, more recently, executive functions have been explored as a contributory factor mainly because of the lack of planning, organisation, automatisation and strategy formation often associated with individuals with reading difficulties (Berninger et al., 2010; Brosnan et al., 2002). Swanson (2006) identified several areas of early reading processes that require executive skills, such as inhibiting irrelevant sounds and blends when decoding words, and accessing words from long-term memory. However, reading task demands change to more advanced language and knowledge-based skills as more demanding texts are encountered (Catts, Hogan & Adlof, 2005; Scammacca, Roberts, Vaughn, & Stuebing, 2013). More specific executive processing is thought to take a prominent role in the upper primary grades and into post primary school (Cartwright, 2015; Meltzer, 2010), as the focus of reading shifts from learning to read, to reading to learn (Chall, 1996).

Several studies of children and adults with reading difficulties have found impairments in executive functions (Brosnan et al., 2002; Swanson, 2006 Martinussen & Tannock, 2006; Miller-Shaul, 2005; Reynor, 2016; Swanson & Saches-Lee, 2001). For example, Miller-Shaul (2005) found statistically lower performance in 25 children and 25 adults with reading difficulties in speed of processing in verbal and non-verbal tasks. In addition, Reynor (2016) found that a group of 72 students with reading difficulties in 6th classes showed significantly poorer executive function performance, as measured by the Comprehensive Trail-Making Test (Reynolds, 2002), than a group of 22 typical age-matched readers. Furthermore, it is thought that these difficulties with executive skills are separable to their well known deficits with phonological processing (Booth, Boyle & Kelly, 2010; Brosnan et al., 2002; Locasio, Mahone, Eason & Cutting, et al., 2010).

Executive Functions and Reading Comprehension

A large body of research supports the view that decoding and word reading deficits adversely affect reading comprehension, and that many children with word reading difficulties also exhibit reading comprehension difficulties (Adams, 1990; Lyon, 1995; Shankweiler, 1999; Torgesen 2000). One reason for this is that it is difficult to gain adequate information from text without the ability to decode accurately. In addition, slow word reading increases the

demands on processes such as working memory which in turn creates difficulties for comprehending text culminating in a processing bottleneck (Perfetti, 1985; Wolf & Katzir-Cohen, 2001). However, reading comprehension difficulties cannot always be attributed to bottom-up deficits such as decoding skills (Cutting et al., 2009; Sesma et al., 2009). Adequate reading comprehension depends on reading skills that include reading fluency, language comprehension, as well as higher-order skills, including those that fall within the scope of executive processes (e.g., planning, monitoring and updating information, organising and cognitive flexibility). For example, Reynor (2016) found measures of executive function were significantly related to reading comprehension (r=.45) in the sample of children with reading difficulties in that study. In fact, controlling for phonological processing, executive functions contributed 11% unique variance to reading comprehension for the sample of children with reading difficulties. Indeed, there is a considerable body of research linking executive processes to reading comprehension (Best, Miller & Naglieri, 2011; Cartwright, 2008; Locasio et al., 2010; Sesma et al., 2009).

Supporting Executive Skills for Reading Comprehension in Post Primary School

There is a general tendency for the importance of early reading skills and reading methodologies (e.g., phonics vs whole language) to dominate the educational agenda in terms of literacy (Vacca, 1998). However, learning from text is at the heart of the process of learning in many subject areas at post primary level and it is therefore important that post primary teachers can support their students in comprehending texts and reading in different subject areas (Shanahan & Shanahan, 2012). The RAND Reading Study Group (2002) state that comprehension is "the process of *simultaneously* extracting and constructing meaning through interaction and involvement with written language" (p. 11). This is an apt definition in which the role of executive functions in the comprehension processes can be clearly seen. Student behaviours associated with poor reading comprehension include the following

General attuitude

- Rarely reads books not required for school
- May read comics and magazines and internet information
- Dreads reading books with small print

Speed

- Often fails to complete reading homework
- Slow reading and often too far behind in reading textbooks to join in discussions

Comprehension

- Has done the reading but does not understand much
- Reads fast, enjoys the book, but remembers little

Silent Reading

- Fidgets, reads in an uninterested way
- Uses finger to guide
- Looses interest

Extracting Information

- Unable to scan a book to find specific information
- Unable to extract information from posters and texts
- Misreads exam questions (adapted from Cartwright, 2015).

Helping Students to Plan and set Goals for Reading

One of the most important executive skills for comprehension involves planning and goal setting before reading (Altemeier et al., 2008; Crook & Evans, 2014; Locasio et al., 2010) Students should be explicitly taught that planning to understand the text is an essential prerequisite of comprehending a text, and some effective planning strategies are needed towards this end. Cartwright (2015) advises that the first step in planning before reading is deciding *why* the text is being read. In other words, what information or knowledge is the student hoping to gain from the text. Finding the purpose of reading a text leads to the *goal* for reading. Once the goal has been identified, it needs to be kept in mind throughout the reading process. There are some well-researched protocols to support this process. Important prompts are presented in Figure 2.

PLAN TO UNDERSTAND

Reading goal: (State what I need to know after I've read the text)

- Prompts:
  - **Preview/Scan** the text (what will help me to reach my goal?)
  - Which **sections** are NB?
  - **Connect** what I know already that's relevant to achieving my goal?
  - **Predict** what's in the text
  - What **other steps** are needed towards the goal?
  - What do **I need to know** after I've read the text?

(adapted from Cartwright, 2015)

Figure 2 Plan for Understanding Text

Firstly, *previewing* of the text is an important first step (Duke et al., 2011). This will give the reader an overview of the structure of the text and its content, in order to identify what information is key for their goal. Readers also need to make connections to their own prior knowledge or schemas (Pressley & Gaskins, 2006) to see what they already know about the topic. It is important to activate prior knowledge in the text as this helps the reader make inferences and fill gaps in the text (Elbro & Bucks-Iverson, 2013). The important text content can then be organised visually. Blank concept maps for useful supports for this process (see Figure 4), (Di Cecco & Gleason, 2002; Robinson, 1998). This map is added to as the reader reads. This process helps the reader organise the text information in working memory as they construct meaning while reading, and also allows the reader monitor the text while reading, which is what skilled readers do (Pressley & Gaskins, 2006)

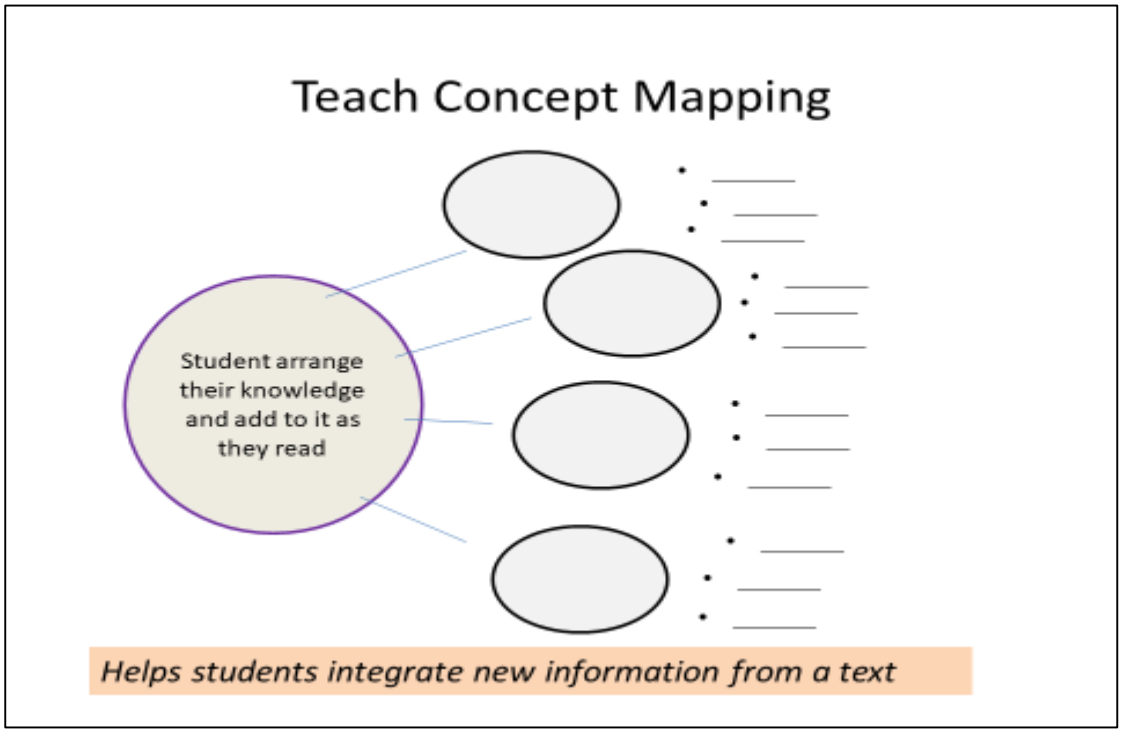

Figure 3 Mapping Text Information

Concept maps can be arranged in different formats depending on the text at hand. For example, a science text may include information on cause and effects, or a sequence of processes, or a problem and possible solutions, which require a concept map design that is organised clearly and sequentially for the reader.

The Modified KWL Strategy

One well-known strategy that supports *activating prior knowledge*, asking questions about the text, and monitoring text, is Ogle's (1986) KWL strategy. This method encourages

readers to document what they already know about the text, what they want to know about the text, and, after reading, what they have learned from the text. This information is documented using a simple chart divided into these three sections (columns). This strategy is especially suited to informational texts. There is a modified version of this strategy designed by Szabo (2006) which develops it in significant ways. In this updated version, in order to help students reflect on their prior knowledge, the first column (what I already know), is divided into 'positive knowledge', 'negative knowledge' and 'neutral knowledge' (see Figure 4). Students are encouraged to critically reflect on their categorisations. Szabo argues that this addition helps students think more critically about the knowledge they already have and recognise that knowledge can be perceived in different ways by different individuals. The second column (what I want to find out) is expanded to include *questions* that are developed before and during reading. Importantly, it reinforces the idea that as they read they may develop more questions. This not only helps engage the reader throughout the reading process, but also provides motivation to monitor the text and construct meaning while reading (Duke & Pearson, 2002). Two new columns are included next, which pertain to the development of new vocabulary. These columns were designed to help students think about the *vocabulary* they encounter in the text as they read (Szabo, 2006). The first one is called 'head words' in which the student documents the difficult and confusing words they encounter as they read. The second of these new columns is called 'heart words'. Heart words are words that trigger emotions or experiences in the reader. The triggered emotions and experiences can vary for students, according to their personal experience or prior knowledge. Students are thus linking old information with new knowledge. Students discuss their heart words and why they have chosen these words, after reading the text. The last column consists of documenting the new information that has been learned. Firstly, students summarise three things they have learned from the text. Then the new information is categorised into information that they already know which stayed the same, information that they knew but can add to, and information that they now need to change. This enables students to *summarise* and *evaluat*e the information they have read. Each section of the KWL chart is discussed and explained to the students before they read a text. As students read through the text they fill their KWL chart, and when they are finished reading, each section of the chart is discussed in turn with the students.

Regular practice using the chart is needed, to encourage and support the development of good executive skills (such as planning, monitoring and updating) for comprehending texts and, in

this case, to encourage vocabulary growth for students who have reading comprehension difficulties (Szabo, 2006). It is important that teachers consistently model the strategies and methods outlined above with their students, and guide and support them in learning to use the strategies independently (Duke et al., 2011; Pearson & Gallagher, 1983).

What do I want to know	What do I want to learn	Head words	Heart words	What have you learned
Before reading: Brainstorm	Questions: Before & During reading	Confusing words	Feeling words	We read to learn: Think about what you have read critically
Positive ideas Negative ideas Neutral ideas	Before Reading 1. 2. 3. During Reading 1. 2. 3. 3.	Head words 1. 2. 3. 4. 5.	Heart words and why 1. 2. 3.	New information I learned 1. 2. 3. • Stayed the same • Corrected • Adjusted because flawed

Figure 4 Modified KWL Strategy

Conclusion

As the National Strategy on literacy (DES, 2011) now aims to develop all post-primary teachers as teachers of literacy, it is incumbent on post primary teachers to guide and support students towards skillful reading comprehension in their subject area. Executive functioning is seen as a supporting factor in the learning process and as a critical facilitator for core skills such as reading comprehension (Christopher et al., 2012; Locasio et al., 2010; Meltzer, 2010). It is hoped that the above recommendations will help teachers give meaningful support to students who have difficulties with the executive processes necessary for effective learning and reading comprehension throughout their adolescent years.

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