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"Hill, Skill, and Will": Dyscalculia and Executive Functioning

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Abstract – In the present educational dynamics various neurological, cognitive, developmental and psychological approaches coexist. Child development and the related anomalies (Developmental Disorders) to developmental mindset have been a matter of both interest and research.One such DD is Mathematical Learning Disability or Dyscalculia. Dyscalculia is that condition which makes the acquisition of numeracy skills, one of the component skill of life difficult. Thus not only hampering their mathematics achievement but also it leads to a demotivating decomposition. This paper endeavours to make this 'invisible disability' visible and acknowledge the need to see a bigger picture. The paper further aims to study Dyscalculia and Executive functioning (EF) and study EF in the developmental perspective and construe as the integration of three parameters ("Hill, Skill & Will") in the long run to accommodate to a better inclusivity and enhanced living experiences.

Keywords: Developmental Disabilities, Learning Disability, Dyscalculia and Executive functioning

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Child development is conceptualised as proceeding along several domains. Development to a layman simply denotes the physical and psychological changes in a person's lifespan. The impairment in one or more of these developmental domains leads to what are called as Developmental Disorders (DDs). The domains can range from physical (height, weight, etc.), speech, language, social, emotional to cognitive. The disorders can or cannot be purely independent of each other. Similarly, the development that is normal in one phase may not be in another. At present, globally there are two classifications, the *International Classification of Diseases (ICD)* followed largely in Europe and Asia and the second is *Diagnostic and Statistical Manual (DSM)* followed by North America. The basic difference between the two being that ICD categories DDs under disorders of psychological development, whereas, DSM categories them under neurodevelopmental disorders, hence focusing on the cognitive domain of the individual. The DDs are commonly divided into seven type and one such 'invisible disability' the current paper is interested in is *Learning Disabilities (LD).*

Learning Disabilities (LD) are a group of disabilities characterised by persistent and significant difficulties in learning academic skills which are reading, numbers and writing. These skills are substantially below the expected levels as compared to the child's age and class. They have also been called Specific Learning Disorders (sLDs). The deficits in these three skills are called Dyslexia (reading), Dyscalculia (numbers) and Dysgraphia (writing), respectively. Learning Disability is a broad-spectrum term but through assessments the specific disability dominant for the problem can be specified. Among the three types of LDs enlisted above Dyslexia is so common that at times LD itself is identified as specific RD (Reading Disability). On the grounds of similar prevalence rate is, yet another Learning Disability, i.e. Dyscalculia of around 6 percent, in India (Ramma & Gowramma, 2002), 6.02 percent (Vashistha & Bapte, 2018), and abroad (Shalev, Aeurbach, Mannor & Gross-Tsur, 2000).

Dyscalculia is less recognized as opposed to Dyslexia. It is a condition which affects the acquisition of numbers. It was first recognized in UK by DfES (2001), which was further defined as 'a condition that affects the ability arithmetic skills. Dyscalculic learners may have difficulty understanding simple number concepts, lack an intuitive grasp of numbers, and have problems learning number facts and procedures. Even if they produce a correct answer or use a correct method, they may do so mechanically and without confidence.' Research into Dyscalculia is still unexplored waters, especially concerning the Indian circumstances. The children with Dyscalculia as described above have their basic struggle attaining

age and class specific numeracy skills. Numeracy as we all very well know is a life skill that is required in our everyday activities, the lack of which is a major setback to the quality of life. Unlike, reading children have an innate ability to acquire numeracy also called as *Number Sense*(Butterworth, 2013), and this innate quality is known as *subitising* (the capability to perceive the amount at a glance without the need to counting). As there is a problem in assessing this very number sense, dyscalculia influence school and life success (Ancker& Kaufman, 2007; Geary, 2011) and this further correlates to a number of higher order cognitive skills (Clements &Sarama, 2011). This captures the attention of research as to what are the indicators for Dyscalculia, how to see the bigger picture?

Dyscalculia: Identifying & Assessment Factors

A frequent question that comes up is that many children are weak in mathematics, or dislike the subject, or maybe doesn't take interest due to poor teaching skills, etc., and it is one of the numerous factors that Dyscalculia is normalised and not catered like its literary counterpart (Dyslexia). Therefore nor the child is sent for assessment neither given some intervention. As learning disabilities are largely said to be identified in educational settings, therefore it becomes important for the teacher to see the early signs and carry out the prognosis, like:

- repetitive error patterns: majorly there are three types of errors showcased by the child, (a) operand error (5*4=24), (b) near miss errors (e.g., 4*3=13), and cross-operational error (e.g., 2*3=5; 2+3=6), etc.
- a weakness in visual and spatial orientation
- misjudgement related to cardinal directions.
- problem related to money handling and related aspects.
- inability to read time from clock.
- identification of strategies: once the teacher understands the constant error pattern and the loophole in the strategy, the child has been using since long, the teacher must tailor-made strategies for the individual, as problems in Dyscalculia are not general rather specific many a times.
- use of standardised assessment tests: majority of the available tests in the market are used by the UK and USA like, Test of Early Math Ability (TEMA-3; Ginsburg & Baroody, 2003); Weschler Test (WIAT-III: Weschler, 2009). Key Math 3 diagnostic assessment (Key Math-3: Cannolly, 2007), to name a few. But once the child is identified and assessed with Dyscalculia, it's time to assess as to what can be done to accommodate him/her not just in the normal classroom but also for life.

Executive function: Development

Executive Function (EF) is a cognitive process involved in controlling behaviour and readying the individual for varied situations. Various factor analysis studies have reported that the arrangement of Executive Functioning has a marked developmental trait. It develops from a nine month infant and continues to develop till early fourth decade of an individual, otherwise said to develop in mid-twenties. As Diamond (2000) puts out that executive functioning develops in interactive fashion involving other cognitive domains, therefore it is said to be the concrete building block. In the medical terms known as 'higher cortical function' or known as 'higher order thinking skills'.

The Executive functions are most commonly studied, as Inhibition (subduingdiverting information and unwanted responses), Shifting (flexibly switching between different tasks) and Updating or Working Memory (monitoring and manipulating information in mind). Similarly, the five areas of Executive Functioning are Organizing, Prioritizing/Planning, Shifting/ Thinking Flexibility, accessing Working memory, and Self-monitoring (National Centre for Learning Disabilities, 2013). On the other hand Dawson &Gaure (2009) referred eleven components or skills of Executive functioning being, Response Inhibition, Working Memory, Emotional control, Sustained attention, Task initiation, Planning/ Prioritizing, Organization, Time-management, Goal-directed persistence, Flexibility, Metacognition and Stress tolerance.

The table 1.1 clearly gives the detail of the major dimensions/sub-componentsof Executive functioning at a glance, considering its developmental significance. The commonality among these tasks is that they are beyond the routine stimulus- response pattern and provides the respondent a novel and dynamic situation each time and aims to encompass the various dimensions of EF like Inhibition, Verbal and Non-verbal component, Planning, Sequencing, etc.

Cantin (2013) inferred from a longitudinal study that better EF during preschool predicted better math performance in middle childhood. Hence, Executive functioning moulds the path to being focused in both practiced and novel situations and giving a well-thought rather than an impulsive response.

"Hill, Skill & Will": The glass to see the bigger picture

The role of Executive functioning (EF) in children's cognition and behaviour has become a focal point of

interest and research, especially in the educational dynamics. It encompasses the ability to be mentally and behaviourally flexible to changing environment and henceforth giving responses. Executive functioning integrates three parameters which are hill, skill and will (Moran & Gardner, 2007). Where in *hill* refers to the goal which is an internal as per the present and future purpose. Whereas, *skill* refers to the discipline that draw on one or more intelligences that is what a person can do, and *will* indicates the effort and motivation to follow the trail. How does the goals, abilities and motivation lead to manifestations of EF? A significant elucidation of the nature of EF, a significant one is their assumed association with the frontal lobes.

These parameters take the form of perfect integrated trail as one grows with age and gains experience. Individual's exhibit individual variations in Executive functioning one reason are the developmental phase and the other being differential interactions of these three parameters during these developmental phases. Thus its important to show a bigger picture to a child with Dyscalculia. Where a major role is played by the teachers, administrators and parents. After the initial identification and assessment of the child in an academic setup, the individual problem regions can be sorted for the child. As the problem is identified, it's imperative to set the goals (hill) for the individual child. Depending on the goals the skill that will be required needs to jotted down. Skill development is actually the most important parameter for school-aged children, as they strive to enhance their abilities. The skill parameter provides the essential guide to use of various statuaries and invention for solving the problems of the child with Dyscalculia, which in turn is the fulfilment of the set goal. Initially the hill or the goals are set by the teacher or parent but with mastery over the skill, several aspects of the goal are transferred to the child. Whereas will is majorly linked with societal traits and expectations. This is controlled by the motivation disposition of the Executive functioning front. Inhibition being one of the components can especially help children to regulate emotions and respond adequately to failure and frustration. Mercader, Miranda, Presentation, Siegen haler & Rosel (2018) clearly cite that mathematics learning and its difficulties require great attention to motivation factor. In the latter time the ultimate aim is the development of executive functioning in the child with Dyscalculia involves gradual fading of external models set by others and the perennial fashioning of a personal model that allows him/her to understand his/her strengths and weakness which enhances his/her chances to reach the top of the set hill.

Table 1.1: Exhibiting the Dimensions of Executive functioning (EF).

SN	Dimensions	Detail
1	Planning	The ability to create steps to reach a goal and to make decisions about what to focus on.
2	Organization	The ability to create and maintain systems to keep track of information or materials.
3	Task Initiation	The ability to begin projects without undue procrastination, in an efficient or timely fashion.
4	Visio-spatial Processing	The capacity to understand reason and remember the spatial relations among objects or space.
5	Verbal Fluency	A cognitive function that facilitates information retrieval from memory.
6	Inhibition	The ability to stop and think before acting.
7	Cognitive Flexibility/Shifting	The ability to change strategies or revise plans when conditions change.

Source: Self-made

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