Executive Functions and Poverty: Implications for Lifelong Teaching

Working in schools with diverse populations such as different socio-economic status (SES), we have had the opportunity tc schools' data from assessments of students' executive functions and other cognitive skills and explore the implications for individual interventions and overall classroom management. As we will explain in this paper, the data suggest that ed have a meaningful impact on closing the achievement gap for low-SES students and helping them develop social anc competence by understanding and addressing the development of cognitive skills in general, and executive functions in Our intent in this article is not to draw statistical conclusions, but rather to illustrate the kinds of challenges and apı addressing those challenges for schools with varying proportions of students living in poverty.

The Impact of Poverty on Cognitive Development

In recent years, poverty's impact on cognitive development has been more widely recognized in education (Budge & Parret has the critical importance of cognitive skills for academic success (Sheppard, 2017). Nonetheless, many educators are not with the cognitive developmental sciences and their implications for teaching and learning (Liebbrand & Watson, 2010). Ou is to demonstrate practical ways to translate the research into meaningful classroom change.

All academic tasks require a range of cognitive skills, and the demands on higher-order skills, including executive functions as students progress in school (Best & Miller, 2010). Executive functions are essential for social and emotional competence self-regulation, control of attention, and openly adapting to changing circumstances (Diamond, 2013). Executive functions a essential in the process of learning to read (Sheppard, 2017, Hill, 2017) and learn mathematics (Hegarty & Koshevnikov, 19 Misunderstood Minds: Basics of Mathematics, 2002).

Rapid developments in neurosciences over the last two decades have exponentially increased our understanding of brain development, the role of the environment, and the negative impacts of poverty. We want to be very clear and do not sugg would the research suggest, that differences in cognitive development are due to inherent genetic differences among grou the study does show the developmental impact of poverty on many students, an impact that educators must understand a provide supports to counteract.

The neuroscience evidence reveals both physical differences in brain development and differences in cognitive skill perforı related to lower SES. Further, the longer children live in poverty, and the higher the degree of poverty, the more marked tł (Hair, Wolfe & Pollack, 2015; Brooks-Gunn & Duncan,1997).

Researchers have found significant differences in certain brain structures, among them the frontal lobes which a volve executive functions, planning, impulse control and control of attention. (Luby, et al., 2013; Brito & Noble, 2014). Direct mea cognitive functioning tell the same story, with poverty affecting measures of attention, working memory, inhibitory control, cognitive processes. (Noble, Mccandliss, & Farah, 2007). In particular, according to Budge & Parrett (2018), "Poverty contrib problems with executive functioning, which includes the ability to plan, self-regulate, attend to tasks, understand what info relevant or irrelevant to a task, and retrieve and store information over time (working memory)." While the impact of pover multidimensional, with nutrition, trauma and chronic stress commonly cited as factors, there is some evidence that as muc of the impact of poverty is accounted for by the richness (or lack thereof) of learning experiences provided to children in th development. (Brooks-Gunn et al., 1993). For example, models of effective planning may be scarce in a family environmen subsistence in the immediate present is paramount.

In other words, difficulties in executive functions affect not only students' ability to learn but also their readiness to learn a the behaviours expected of them in a classroom setting.

School Experiences

Our interest in the impact of poverty on cognitive development intensified after noticing differences in cognitive measures schools we work with. It is worth noting that all of the schools we talk about here, regardless of neighbourhood, had been s for a solution to help them understand individual student learning strengths and weaknesses, to identify any non-academi low academic performance, and to personalize learning supports. The cognitive assessment used in these schools is a nati normed battery of cognitive tests known as the Penn Neurocognitive Battery (Gur et al., 2010) distributed commercially un name Mindprint Learning. Students scoring one standard deviation below the mean (bottom 16% of the population) based national norms on any skill are considered to be "at risk" for that particular skill. Such students will require support to over potential academic and behavioural impact of that deficit. Students performing at one standard deviation above the mean considered to have a strength in that skill. Students in the middle, 68% are considered to be in the normal range of cogniti development relative to their same-age and same-gender peers.

The executive functions assessed in the Mindprint battery include Attention and Working Memory. The Attention subtest re subject to press the space bar on the computer keyboard whenever a 7-segment display (much like the numbers on a digit form a complete digit or letter. The task creates a demand for sustained attention similar to that needed to follow through frustrating homework assignment. The Working Memory subtest is a version of commonly used working memory assessm 0, 1 and 2 n-back conditions.

The urban charter school data we are sharing comes from two schools whose populations qualify to receive meals at no co reduced cost in school because of their low economic status. The suburban public-school data is from a middle school in a suburb. The urban-outskirts elementary school data comes from a traditional public school within city limits, mainly across from the suburbs but still only a stone's throw away from lower-SES communities. Again, o

The data from these schools reflect what the research would suggest. On the tests of executive functions, more than 70% o students in both urban charter schools scored in the "at-risk" range, that is, in the bottom 16% of the population, For the su middle school group, only 32% performed in that range. The urban-outskirts data fell right in between, albeit closer to the s school. Figure 1 displays the data for each of the schools.

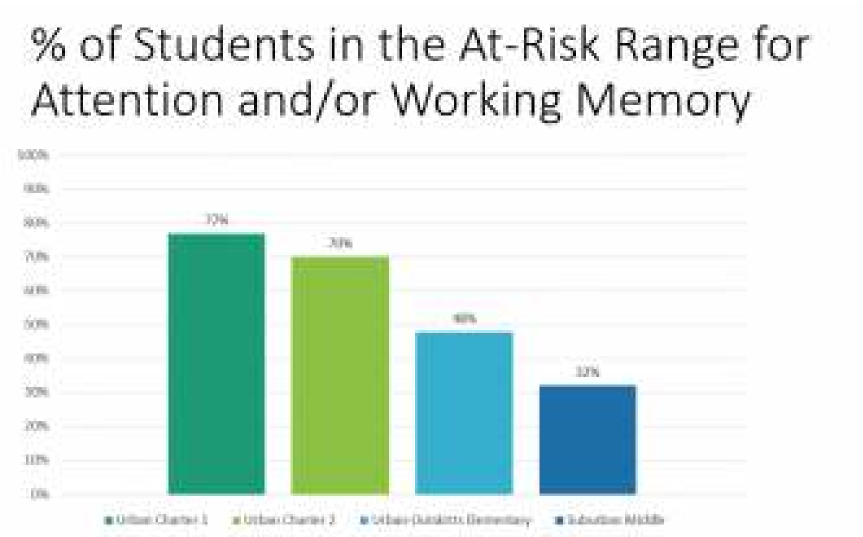

Figure 1.

The disparity in scores between these groups of students is not limited to executive functions, although the disparity is hig than in other cognitive processing areas. Figure 2 shows the percentage of students who scored in the at-risk range in verb abstract reasoning.

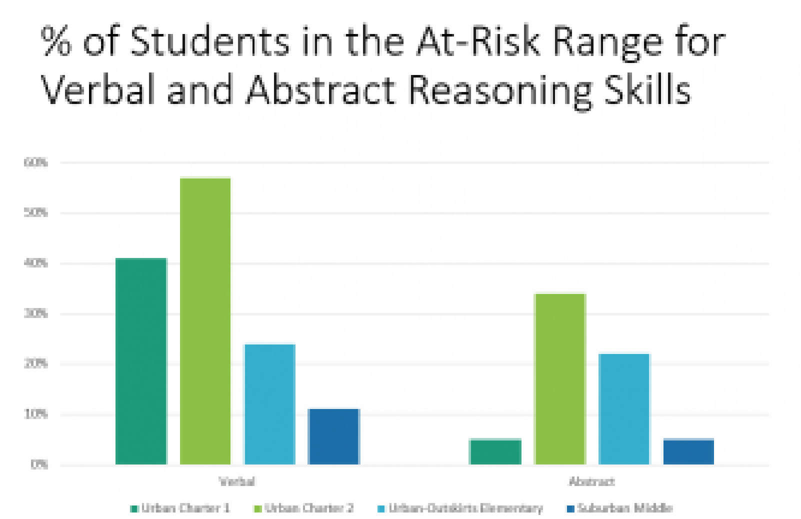

Figure 2.

While the verbal reasoning scores follow a pattern similar to executive functions, one of the charter schools perfo[illegible]ed cor the suburban middle school in abstract reasoning and well ahead of the urban-outskirts public school. Abstract thinking p critical role in complex problem-solving, and these data suggest what we know to be exact – they are capable students; the

grown up in environments that did not nurture their cognitive capacity at the same rate as for more socio-economically ad
students. We note again that this is an assessment of students at a particular point in time, not a life sentence. Indeed, as
below, the research on neuroplasticity suggests that schools have the power to effect positive change for these students.

Implications for Teaching

We can confidently recommend that all students in the at-risk range for one or more cognitive skills, regardless of backgro
need something other than instruction, as usual, to be successful in meeting academic expectations. For teachers managi
of students where the vast majority are "at risk" in executive functioning, the implications are even more significant. Noise,
disorganization and poorly regulated behaviour are the first things that come to mind. Also, when teacher-imposed contro
students sitting quietly in their seats, those underdeveloped executive functions skills are still going to impede learning.

There are two basic approaches schools can use to address the issue – provide supports and strategies to help students w
cognitive weaknesses – and provide cognitive training to help students strengthen those skills.

Supports and Strategies

Strategies to support weaker cognitive areas are vital in helping students succeed in school, as the vast literature on learni
disabilities and effective instructional practices attest. (Hattie, 2012). Armed with specific data on each child's cognitive stre
needs, the root causes of many academic struggles and the appropriate evidence-based strategies for each student need r
be a matter of guesswork.

While a comprehensive review of strategies to support weak cognitive skills is beyond the scope of this article, we provide t
popular examples of relatively easy-to-implement classroom strategies tied to specific executive function deficits:

Working Memory. Difficulty holding information in short-term memory can affect a student's ability to follow instructions, r
and comprehend what they read, or complete multi-step math problems.

- When a student has difficulty following a set of instructions due to limited working memory capacity, teachers may v these popular strategies:
    - Chunk information in manageable amounts to avoid overloading working memory.
    - Have students create a written checklist to free up space in working memory.
- When students struggle with reading comprehension due to working memory constraints, key strategies can include
    - Providing background information or a list of questions before the student reads the text.
    - Having the student stop to summarize at regular intervals to ensure comprehension.
- When difficulty solving a multi-step problem or task is evident because working memory capacity is insufficient to er student to keep track of which step they are on and which is next, popular strategies include:
    - The intended use of written checklists to make sure students do not miss critical steps.
    - Permitting/encouraging the use of a calculator to avoid requiring calculation information to be stored in work memory.

Inhibitory Control and Attention. Weaknesses in attention and inhibition make it difficult for students to focus. Essential su
include minimizing external distractions such as noises and

non-essential desktop items, physical outlets to release excess energy (e.g., stress balls, stretching), and allowing for freque scheduled “brain breaks” (e.g., every 20 minutes). Far from interfering with efficient learning as some administrators might more learning will happen for these students overall, despite the potentially reduced amount of seat time, if students are g necessary breaks.

<u>Cognitive Flexibility.</u> Students who struggle to adapt to change will benefit from deliberate

instruction in how to identify multiple problem-solving options when faced with a complex task, and self-awareness of whe to ask for help.

All of these strategies are familiar to trained teachers accustomed to learner variability, but they become even more essent classroom where as many as three of four students are struggling to focus.

Training Executive Functions and Other Cognitive Skills

Just as there is growing scientific consensus that environmental factors can affect cognitive development, so is there moun evidence that certain practices can improve executive functions and other cognitive skills in a school setting. The most pers evidence exists for computerized training, traditional martial arts, mindfulness and some specific curricula (e.g., Montessor (Diamond, 2013). The school identified as Urban Charter 2 describes itself as built on community engagement, project-base socio-emotional and neuroscientific research.” It has been using daily mindfulness sessions and traditional martial arts trai beginning with the 2017-18 school year. The school will be implementing computer-based cognitive training during the 201 school year. The school identified as Urban Charter 1 has already begun implementing computer-based cognitive training, using the kinds of supports and strategies described above. The urban-outskirts school practices mindfulness and emphas growth mindset throughout the curriculum.

There are some promising indications that comprehensive, integrated computer-based cognitive training can play a role in strengthening cognitive deficits with a consequent improvement in academic performance, including students from povert Sawtelle, 2007; Avtzon, 2012; Research Summary, 2017). For example, a group of struggling readers in an urban economica disadvantaged public school in Indiana raised their scores on the Verbal portion of the CogAT (Cognitive Abilities Test) from to the 48th percentile in 12 weeks (BrainWare, SAFARI Cognitive Skills Development, 2015). The economically disadvantage in the Chicago area in 2nd through 8th grades have experienced 1.5 to 3.0 Grade Equivalent (GE) improvements on Woodc Johnson III cognitive tests, along with 0.5 to 3.9 GE improvements on academic tests, following ten weeks of cognitive traini of BrainWare SAFARI, 2009). These results suggest the potential to go beyond merely helping students work around their d improving their capacity to learn.

Concluding Thoughts

We believe it is essential to increase awareness among educators of the underlying reasons why their students may be underperforming academically or exhibiting behavioural issues. While every student comes to the classroom with an ability environmental factors play a significant role in students’ developed capacity to learn. Most importantly, educators have the to engender change in students’ learning trajectory. If we want students whose development has been adversely impacted environment to achieve as well as their more socio-economically advantaged peers, we need to prepare them and their tea the appropriate support and tools that reflect their diverse environments and needs.

The schools we are working with have embraced a combination of strategies and support, informed by cognitive assessme
While it is too soon for results from these particular schools, the approaches are based on evidence, and teacher feedback
We hope that other educators see the promise of these results and consider how they can make similar practical yet effect
changes in their schools.

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1. Betsy Hill is President of BrainWare Learning Company. An experienced educator, she has studied the application o neuroscience to teaching and learning with Dr Patricia Wolfe and other experts in the field and works to help solve s most long-standing and perplexing problems in education, including closing the gap for historically underperformin She holds a Master of Arts in Teaching and MBA degrees from Northwestern University.

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