Executive Functions and the Science of Reading

Lessons from Tools of the Mind
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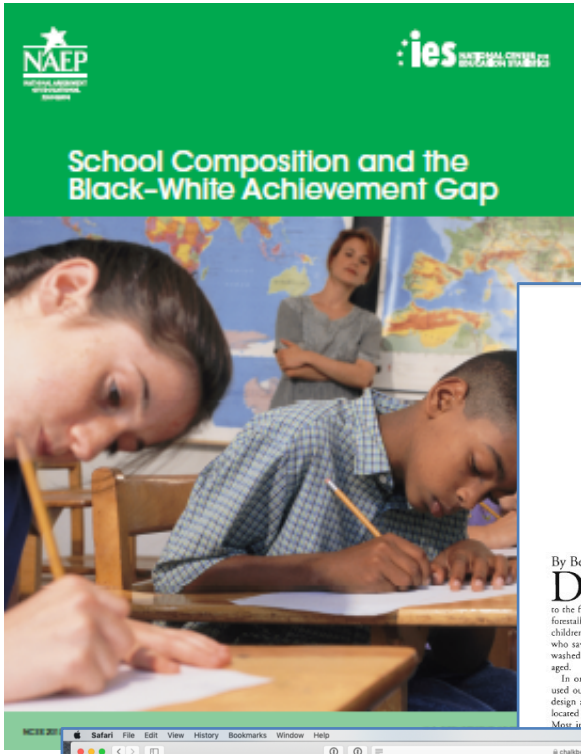
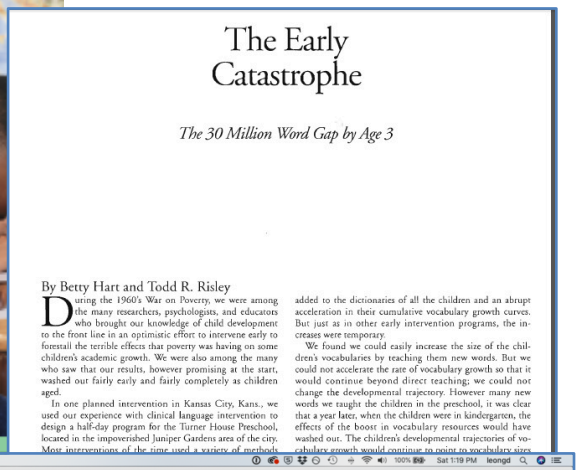
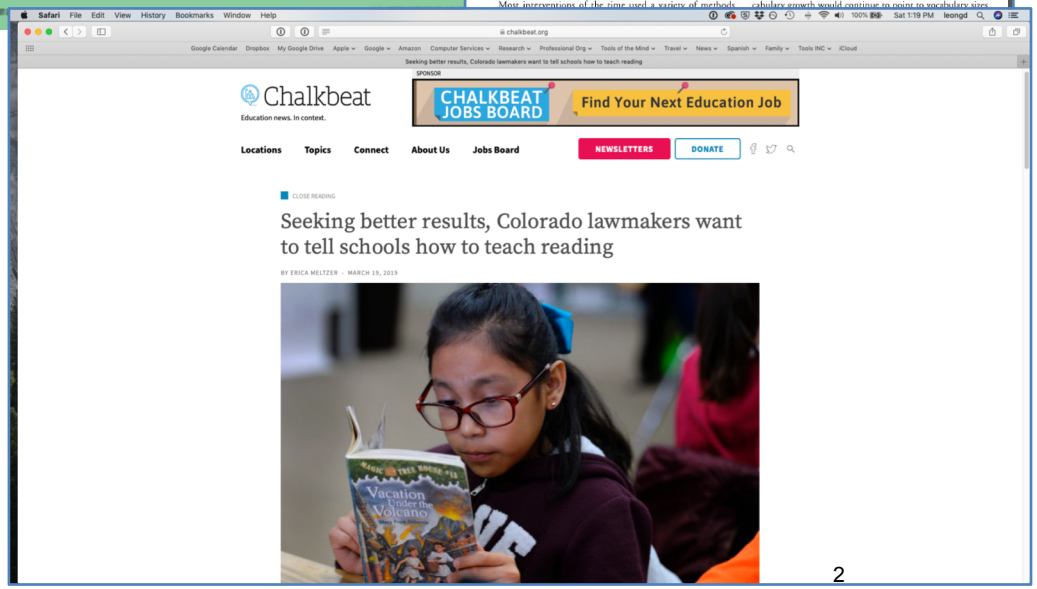
TOOLS OF THE MIND

The Problem

The 3rd grade reading achievement gap has not budged since the 1990s







The Science of Reading

- The content/skills that young children need to know in order to read have been identified in numerous reports (e.g., National Reading Panel)

Can it be something else—more than just the teaching of content but how we teach the content?

Pedagogy of Poverty

- Early assignment into ability groups that destroy motivation, discourage persistence and lead to intellectual inequities
- Use of “kill and drill” associative learning—At-risk children spend 4x’s as much time on drill on sub-skills
- Use of public error making without social support
- A “deficit focused” approach, believing that at-risk children learn and are motivated in a “different” way
- Cutting out play, recess and other important activities (art, music, etc.) that teach to the whole child
- Constant assessment that doesn’t help teachers understand how children are learning

School is a high-stress place for children already coming from stressful homes

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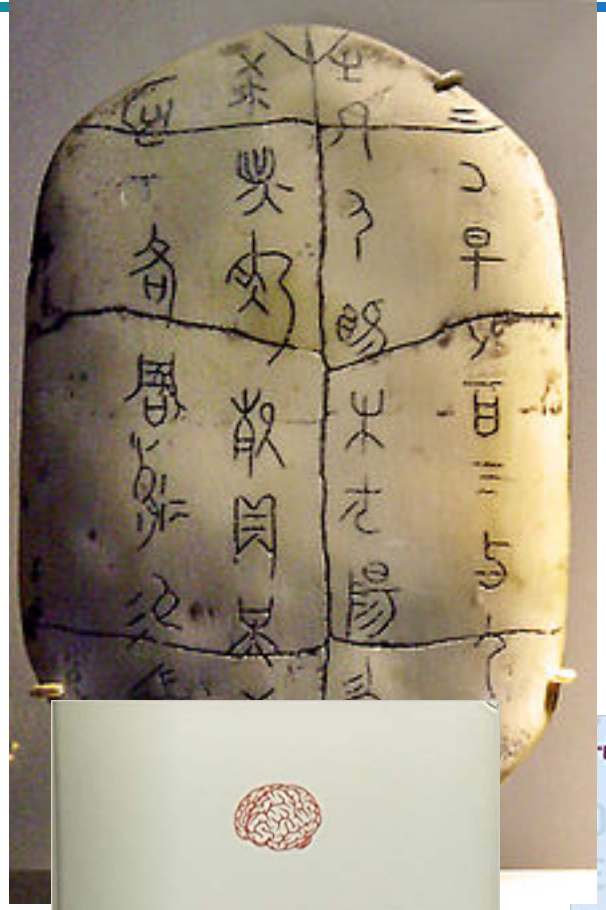
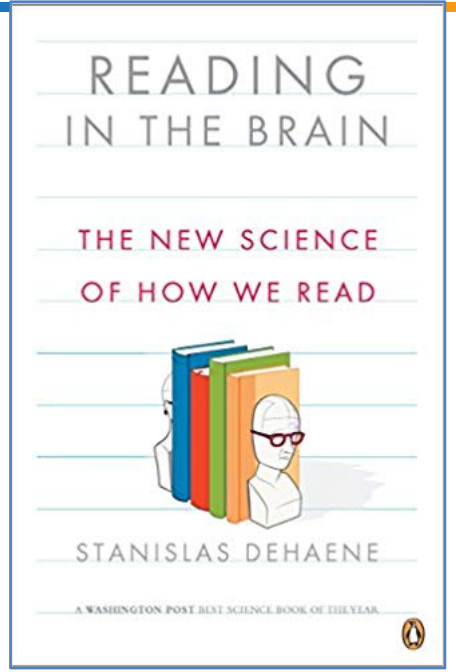
How we teach is important as what we teach

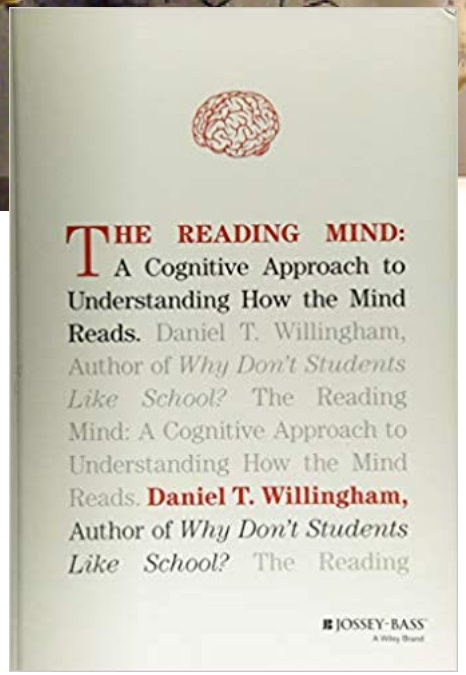
We need to find a better way to close the achievement gap—one that supports all children in the difficult task of learning to read and write

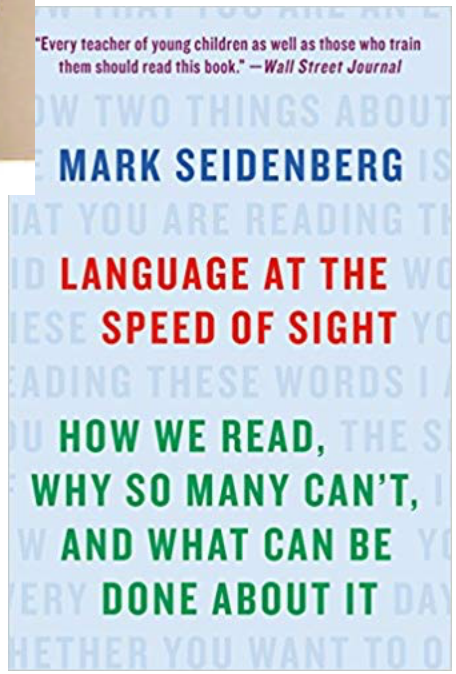
Changing the Reading Paradigm

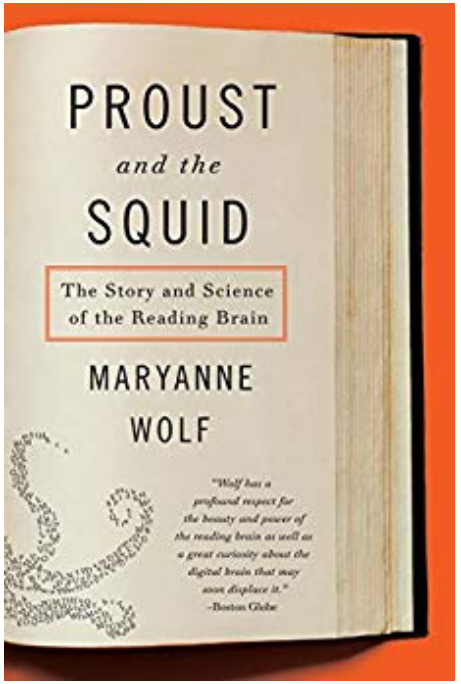




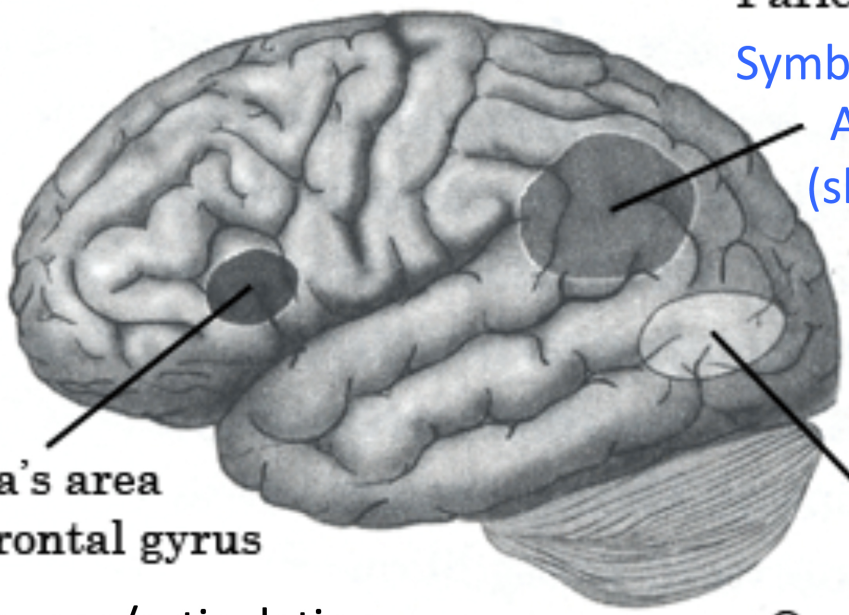
Neuroscience research on reading shows that reading actually repurposes parts of the brain to act in concert in a different way







The Reading Brain



Parieto-temporal

Symbol to Sound

Analysis-Recognition

(slower processing)

Broca's area

Inferior frontal gyrus

Oral Language/articulation

Occipito-temporal

Visual Word Recognition

(quick processing)

The Reading Brain

- Unlike oral language we are not wired to read—you learn to read
- Learning to read results in fluent interactions so eventually the brain fires in a different way once you learn
- Once a person reads they cannot "undo" the coordination
- **Executive Functions** play a key role in the development of reading

The Reading Brain

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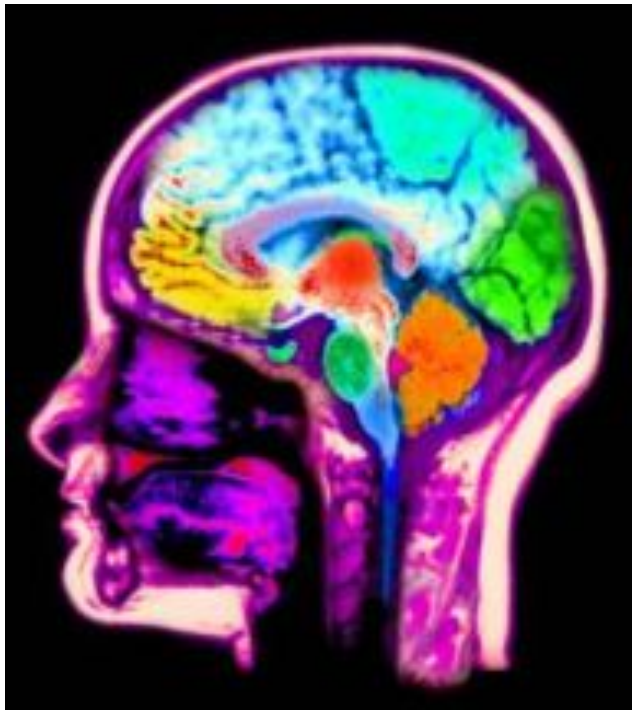
Executive Functions (EFs)

- Related to development of the prefrontal cortex
- A core process that influences both cognition and emotions
- Necessary for learning-related skills
- Coordinates the functioning of the "reading brain"



Newsweek

MIND MATTERS Wray Herbert

Is EF the New IQ?

Why the ability to resist distraction, a skill scientists call "executive function," may be more important to academic success than traditional measures of intelligence.

Jun 4, 2008 | Updated: 10:27 a.m. ET Jun 4, 2008

Avens Publishing Group
J Neurol Psychol
Special Issue 2015

Relationships between Executive Function and Emotional Regulation in Healthy Children

Abstract

As an aspect of cognitive control, emotion regulation has been thought to be closely associated with executive functioning. Previously proposed models have indicated that they are bidirectionally linked, suggesting that deficits in one area of functioning may generate deficits in the other. The current study sought to investigate the relationships between executive functioning and emotion regulation in healthy children ages 8-12 by examining associations between standardized measures of executive functioning and emotion regulation. Children were administered neuropsychological and self-report measures of emotion regulation and executive functioning while parents completed behavioral ratings of these abilities. Associations between behavioral ratings and neuropsychological measures indicated that greater proficiency in executive functioning skills was associated with greater emotion regulation capabilities. These findings extend prior work showing that executive functioning and emotion regulation are linked, and may have important implications for treatment planning in clinical populations with weaknesses in these areas.

coping styl
experience
emotion reg

The pre
throughout

- EFs are more highly correlated with academic achievement than IQ, Social Class, Parent Education, and entry readiness skills
- EFS are highly correlated with social skills, mental health, and the ability to regulate emotions and manage stress

TOOLS OF THE MIND

Executive Functions

- Inhibitory or Effortful Control
- Working Memory
- Cognitive Flexibility

e.g., Miyake, et. al, 2000; Lehto et. al. 2003; Hunzinga, et. al 2006; Center on the Developing Child at Harvard University, 2011

Inhibitory Control

http://www.squidoo.com/childtempertantrums

http://www.flonline.pro/en/image-details/1716222.html

Inhibitory, Effortful, Self-Control

- Controlling anxiety when you make mistakes
- Controlling your temper when you don't get your way or what you want
- Being able to stop and think before you act
- Stopping yourself from using the first strategy that comes to mind in favor of a second

e.g., Blair, Zelazo, & Greenberg, 2005; Jones, Rothbart & Posner, 2003

Working Memory

Ability to hold information

“in mind”

Working Memory

- Thinking about information and being able to work with it at the same time
- Holding two different strategies in mind and deciding on the most applicable.
- Being able to reflect on one's thinking—how you got an answer
- Thinking about more than one perspective at the same time.

e.g., Baddeley, 1992; Roberts & Pennington, 1996; Zelazo, et al. 2003

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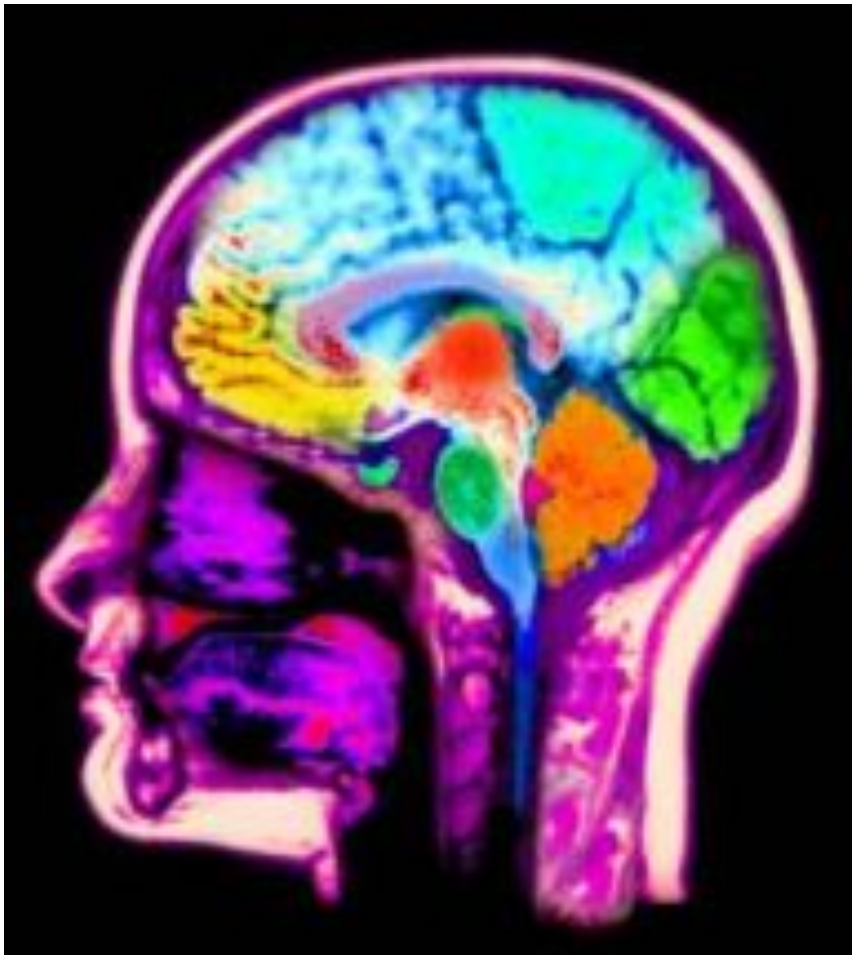
Cognitive Flexibility

Change and adjust mental effort

Cognitive Flexibility

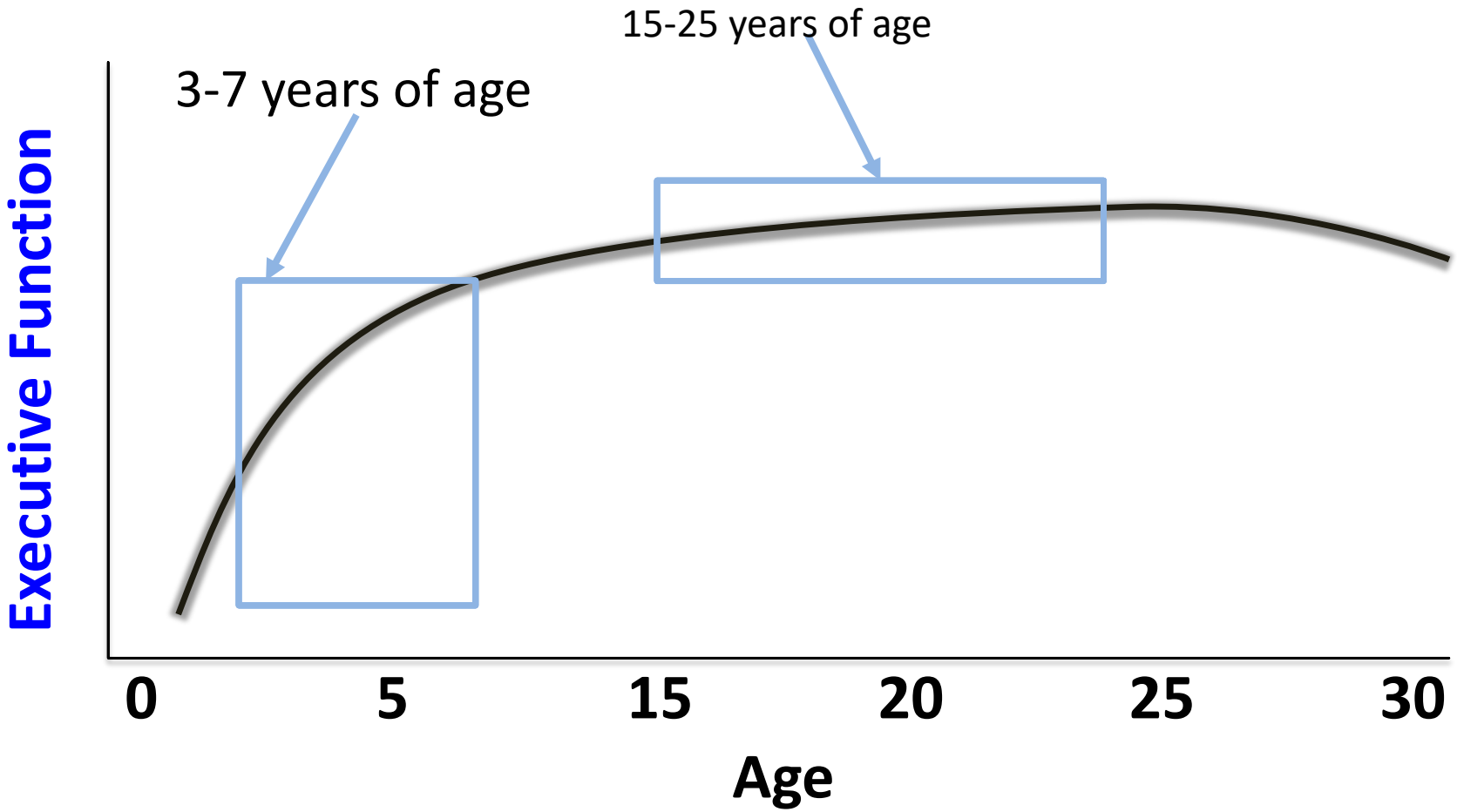
- Shifting actions or attention back and forth between different elements on purpose
- Investing more mental energy when needed

Executive Functions



Executive Functions are needed when you are trying to learn something new that is complex

Developmental trajectory of EF



Carlson, 2012

THE EARLY YEARS

Preschool Program Improves Cognitive Control

Cognitive control skills important for success in school and life are amenable to improvement in at-risk preschoolers without costly interventions.

Adele Diamond,[1]* W. Steven Barnett,[2] Jessica Thomas,[2] Sarah Munro[1]

Executive functions (EFs), also called cognitive control, are critical for success in school and life. Although EF skills are rarely taught, they can be. The Tools of the Mind (Tools) curriculum improves EFs in preschoolers in regular classrooms with regular teachers at minimal expense. Core EF skills are (i) inhibitory control (resisting habits, temptations, or distractions), (ii) working memory (mentally holding and using information), and (iii) cognitive flexibility (adjusting to change) (*1*, *2*).

Significance

EFs are more strongly associated with school readiness than are intelligence quotient (IQ) or entry-level reading or math skills (*3*, *4*). Kindergarten teachers rank skills like self-discipline and attentional control as more critical for school readiness than content knowledge (*5*). EFs are important for academic achievement throughout the school years. Working memory and inhibition independently predict math and reading scores in preschool through high school [e.g., (*3*, *6*, *7*)].

Many children begin school lacking in EF skills (*5*). Teachers receive little instruction in how to improve EF and have preschoolers removed from class for poor self-control at alarming rates (*8*, *9*). Previous attempts to improve children's EF have often been costly and of limited success (*10*–*12*). Poor EFs are associated with such problems as ADHD, teacher burnout, student dropout, drug use, and crime (*2*). Young lower-income children have disproportionately poor EFs (*13*, *14*). They fall progressively farther behind in school each year (*15*).

The Study

The opportunity to evaluate Tools of the Mind (Tools) and another curriculum arose when a low-income, urban school district agreed to randomly assign teachers and children to these two curricula. Our study included 18 classrooms initially and added 3 more per condition the next year. Quality standards were set by the state. All classrooms received exactly the same resources and the same amounts of teacher training and support (*2*). Stratified random assignment of teachers and assistants minimized confounds due to teacher characteristics.

"Buddy reading." Two preschoolers engaged in Tools activity. The ear line-drawing held by one guides her attention (*2*).

EF-training curriculum: Tools. The Tools

their second year of preschool (average age: 5.1 years in both) who received dBL or Tools for 1 or 2 years. Those who entered in year 2 had attended other preschools for a year. All came from the same neighborhood and were randomly assigned to Tools or dBL with no self-selection into either curriculum. All came from low-income families; 78% with yearly income <$25,000 (*2*).

After year 1, so convinced were educators in one school that Tools children were doing substantially better than dBL children that they halted the experiment in their school, reducing our sample of dBL children.

Measures of EF. Outcome measures (the Dots task and a Flanker task) were quite different from what any child had done before. These measures are appropriate for ages 4 through adults, assess all three EF components, and require prefrontal cortex (*20*–*21*). They were administered in May and June of year 2.

In all conditions of the Dots task (*20*), a red heart or flower appeared on the right or left. In the congruent condition, one rule applied ("press on the same side as

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PLOS ONE

Closing the Achievement Gap through Modification of Neurocognitive and Neuroendocrine Function: Results from a Cluster Randomized Controlled Trial of an Innovative Approach to the Education of Children in Kindergarten

Clancy Blair*, C. Cybele Raver

Department of Applied Psychology, Steinhardt School of Culture, Education, and Human Development, New York University, New York, New York, United States of America

Abstract

Effective early education is essential for academic achievement and positive life outcomes, particularly for children in poverty. Advances in neuroscience suggest that a focus on self-regulation in education can enhance children's engagement in learning and establish beneficial academic trajectories in the early elementary grades. Here, we experimentally evaluate an innovative approach to the education of children in kindergarten that embeds support for self-regulation, particularly executive functions, into literacy, mathematics, and science learning activities. Results from a cluster randomized controlled trial involving 29 schools, 79 classrooms, and 759 children indicated positive effects on executive functions, reasoning ability, the control of attention, and levels of salivary cortisol and alpha amylase. Results also demonstrated improvements in reading, vocabulary, and mathematics at the end of kindergarten that increased into the first grade. A number of effects were specific to high-poverty schools, suggesting that a focus on executive functions and associated aspects of self-regulation in early elementary education holds promise for closing the achievement gap.

Citation: Blair C, Raver CC (2014) Closing the Achievement Gap through Modification of Neurocognitive and Neuroendocrine Function: Results from a Cluster Randomized Controlled Trial of an Innovative Approach to the Education of Children in Kindergarten. PLoS ONE 9(11): e112393. doi:10.1371/journal.pone.0112393

. Data are available from the DRYAD Digital

s.ed.gov/. The funders had no role in study

that executive functions, defined as ng memory, and inhibitory control are edict academic achievement in children socioeconomic status [15,16]. Although fined by a specific set of cognitive skills, arger self-regulation system consisting of yed along a continuum from effortful to higher order construct embodying the nent of attention and emotion for the action, executive functions can be activity in lower level neural systems emotion, and physiological responses to influence of executive functions is their emphasized in theory and research on . The relation of executive functions to ver, is reciprocal. Changes in emotional esponse to stimulation are accompanied as indicated by circulating levels of e and norepinephrine, and the steroid uence and can at high levels overwhelm al cortex, the seat of executive function

TOOLS OF THE MIND: IMPACTS ON DUAL LANGUAGE LEARNERS

Clancy Blair, M. Paula Daneri, Carol Scheffner-Hammer, & Lisa Lopez

SRCD, 2017

Lessons from Tools of the Mind

- Activities designed to develop EFs in Pre-K and K classrooms can improve EFs (and achievement)
  - Activities can provide direct practice in EFS
  - EFs practice can be embedded in content activities
- Increasing intellectual equity can increase motivation and persistence
- Increasing reading practice can increase reading fluency

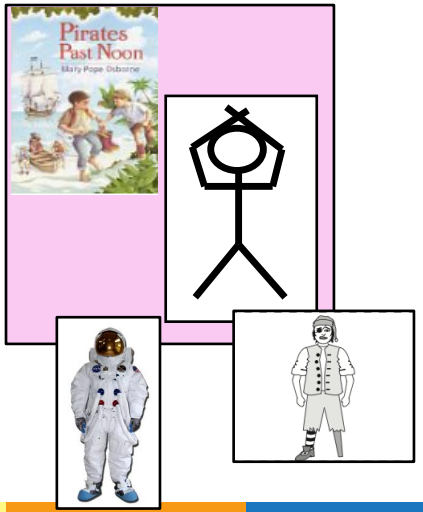
Focusing on Developing EFs
Make-Believe Play

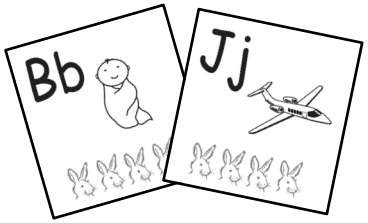
The School for Self-Regulation
Mature Make-Believe Play

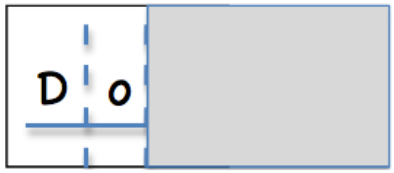
- Deep engagement
- Planned in advance
- Roles with rules
- Scenarios that change and adapt and that require remembering and living the story
- Symbolic props
- Language used to plan the play
- Children voluntarily self-regulate, accept regulation from peers and 'other-regulate'

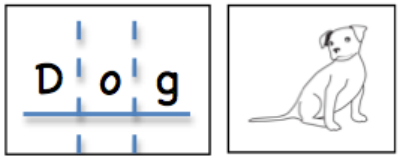
Comprehensive, Immersive Approach

- Themes that organize and integrate learning
- Dramatization and Make-Believe Play that bring ideas to life
- Playful self-correcting learning games to practice sub skills





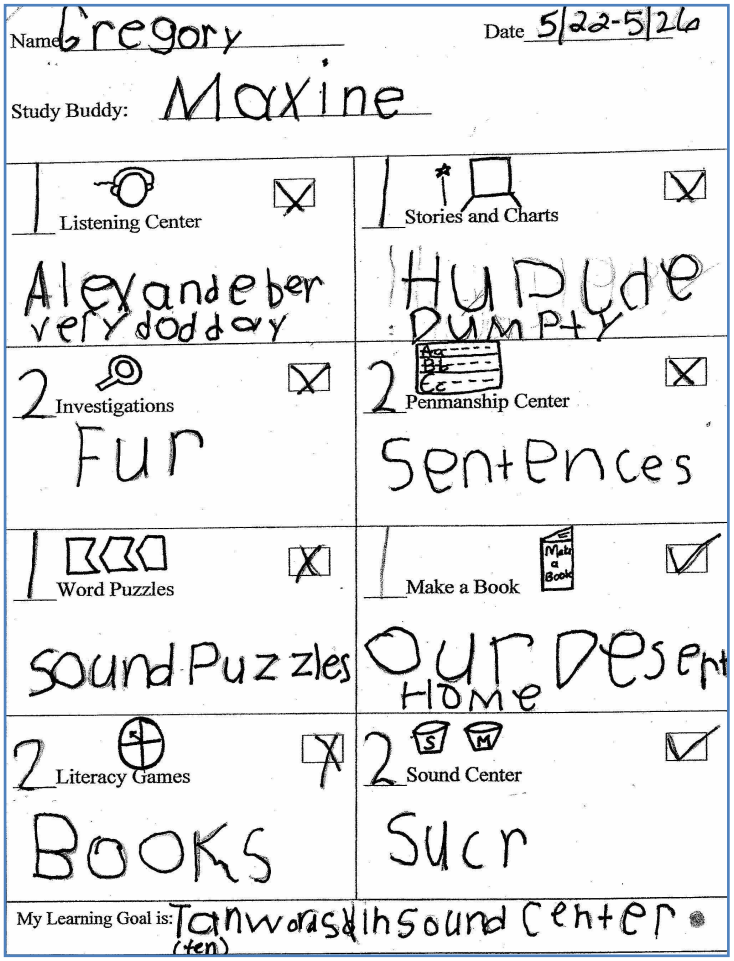




Embedded EFs Practice

Plan, Do, and Reflect = Self-Regulated Learning

Plan Dramatization (Play)



Plan Learning

Intellectual Equity = Motivation

Increasing Reading Practice
Learning to Read by Reading

3 integrated components:

Reading system

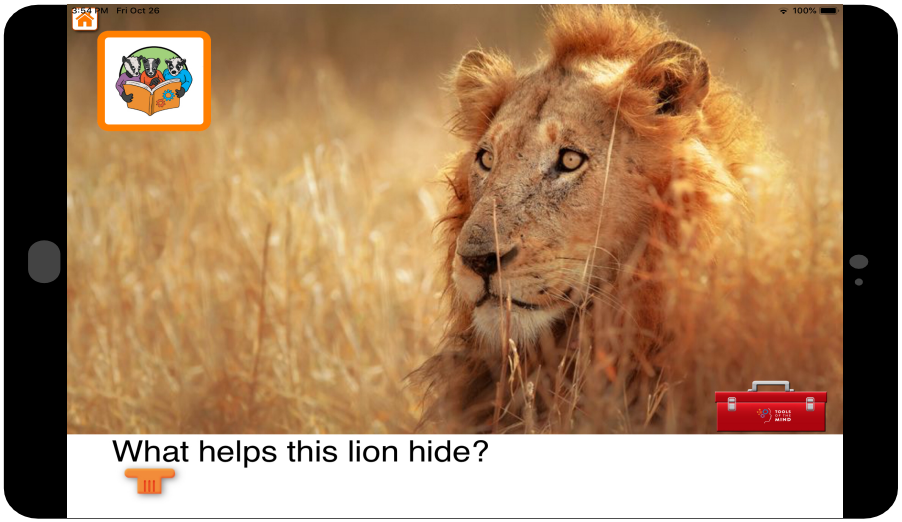
Interactive Read Alouds

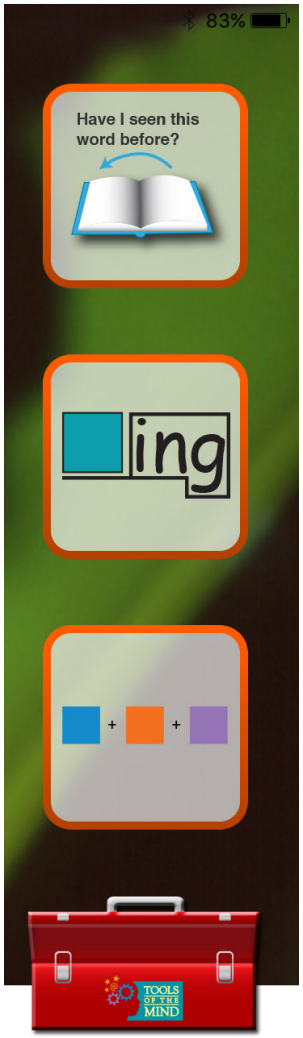
Science Minds Activities

1

Embeded Executive Functions

Children are prompted to act in an intentional way and reflect on what they learn





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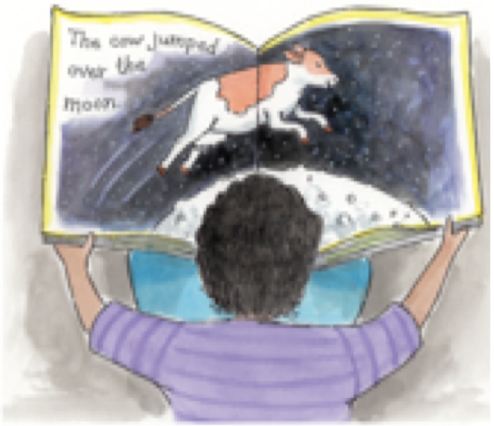
Personalized Instruction

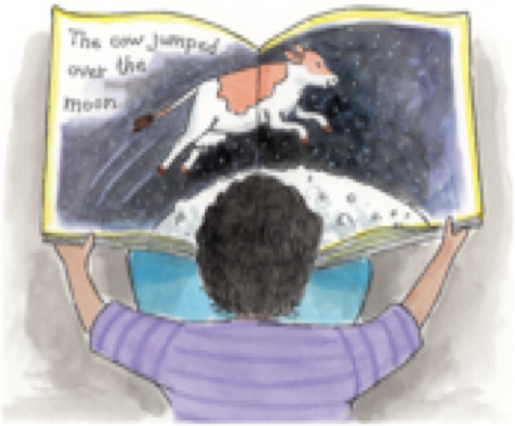
Same content, personalized levels of text difficulty and practice

Low level



Can a cow jump?

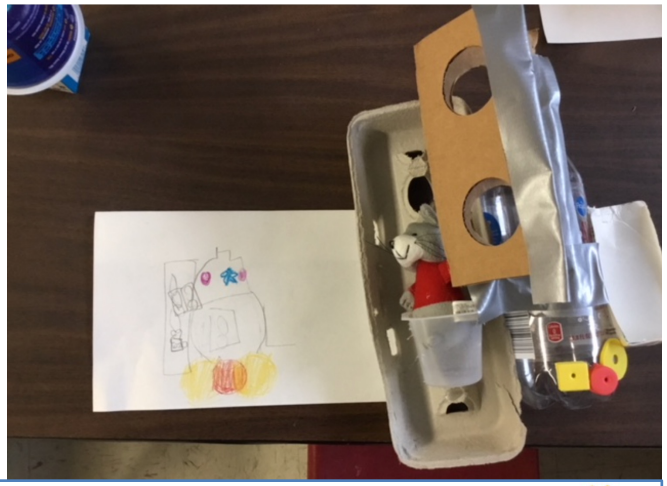
Mid level



The cow jumped over the moon.

3

Enables Social Reading and Writing



Hands on science activities that all children can do

TOOLS OF THE MIND

PowerTools: Science Minds
Ocean: Ocean Engineering

Ocean Engineering

Explore the deep sea!
Design equipment that lets you explore the midnight zone.

eepest layer of the ocean where there
oxygen and a way to stay safe from the
igned to allow humans to explore the
motely operated underwater vehicles.

Learning goals

odel device for exploring

What do children do?

4

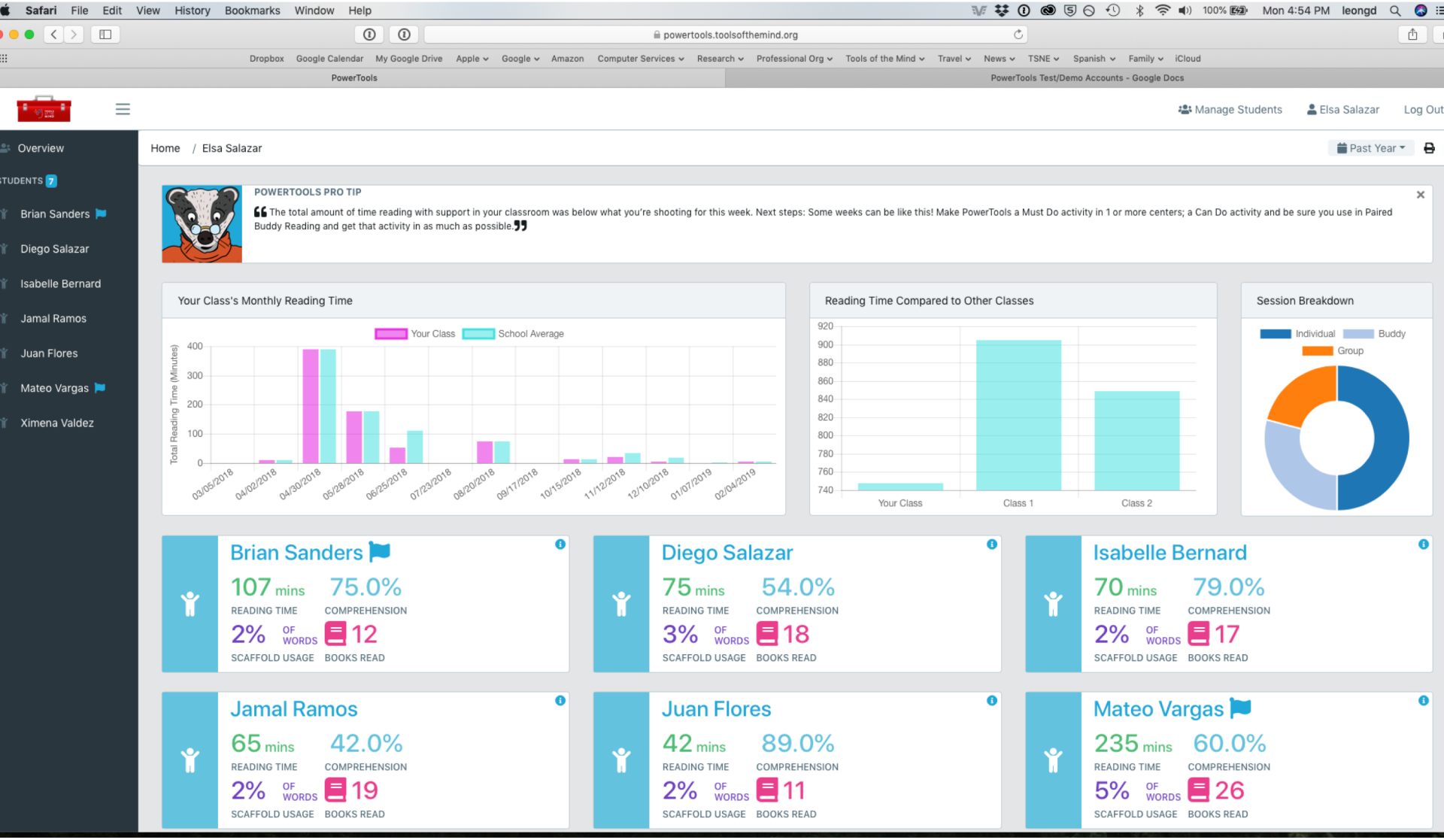
Motivates Readers

When children read independently, they have support similar to what the teacher would provide—cutting down on errors

5

Tracks Progress without Constant Standardized Testing

Instead of relying only on testing of isolated skills, children's daily efforts to learn to read and write form the basis of instructional decisions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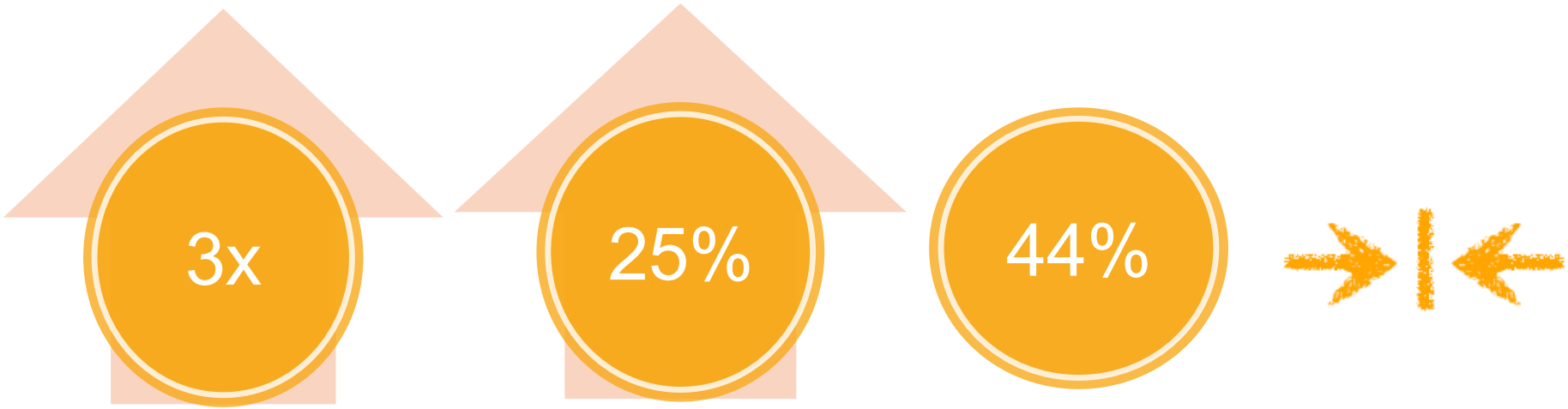
PowerTools Test/Demo Accounts - Google Docs
Manage Students
Elsa Salazar
Log Out
Overview
STUDENTS 7
Brian Sanders
Diego Salazar
Isabelle Bernard
Jamal Ramos
Juan Flores
Mateo Vargas
Ximena Valdez
Home / Elsa Salazar
Past Year
POWERTOOLS PRO TIP
The total amount of time reading with support in your classroom was below what you're shooting for this week. Next steps: Some weeks can be like this! Make PowerTools a Must Do activity in 1 or more centers; a Can Do activity and be sure you use in Paired Buddy Reading and get that activity in as much as possible.
Your Class's Monthly Reading Time
Your Class
School Average
Total Reading Time (Minutes)
400
300
200
100
0
03/05/2018
04/02/2018
04/30/2018
05/28/2018
06/25/2018
07/23/2018
08/20/2018
09/17/2018
10/15/2018
11/12/2018
12/10/2018
01/07/2019
02/04/2019
Reading Time Compared to Other Classes
920
900
880
860
840
820
800
780
760
740
Your Class
Class 1
Class 2
Session Breakdown
Individual
Buddy
Group
Brian Sanders
107 mins
READING TIME
75.0%
COMPREHENSION
2% OF WORDS
SCAFFOLD USAGE
12
BOOKS READ
Diego Salazar
75 mins
READING TIME
54.0%
COMPREHENSION
3% OF WORDS
SCAFFOLD USAGE
18
BOOKS READ
Isabelle Bernard
70 mins
READING TIME
79.0%
COMPREHENSION
2% OF WORDS
SCAFFOLD USAGE
17
BOOKS READ
Jamal Ramos
65 mins
READING TIME
42.0%
COMPREHENSION
2% OF WORDS
SCAFFOLD USAGE
19
BOOKS READ
Juan Flores
42 mins
READING TIME
89.0%
COMPREHENSION
2% OF WORDS
SCAFFOLD USAGE
11
BOOKS READ
Mateo Vargas
235 mins
READING TIME
60.0%
COMPREHENSION
5% OF WORDS
SCAFFOLD USAGE
26
BOOKS READ

In 4 months, **PowerTools** achieved



Time spent **in supported error-free** reading

More children reaching grade-level expectations

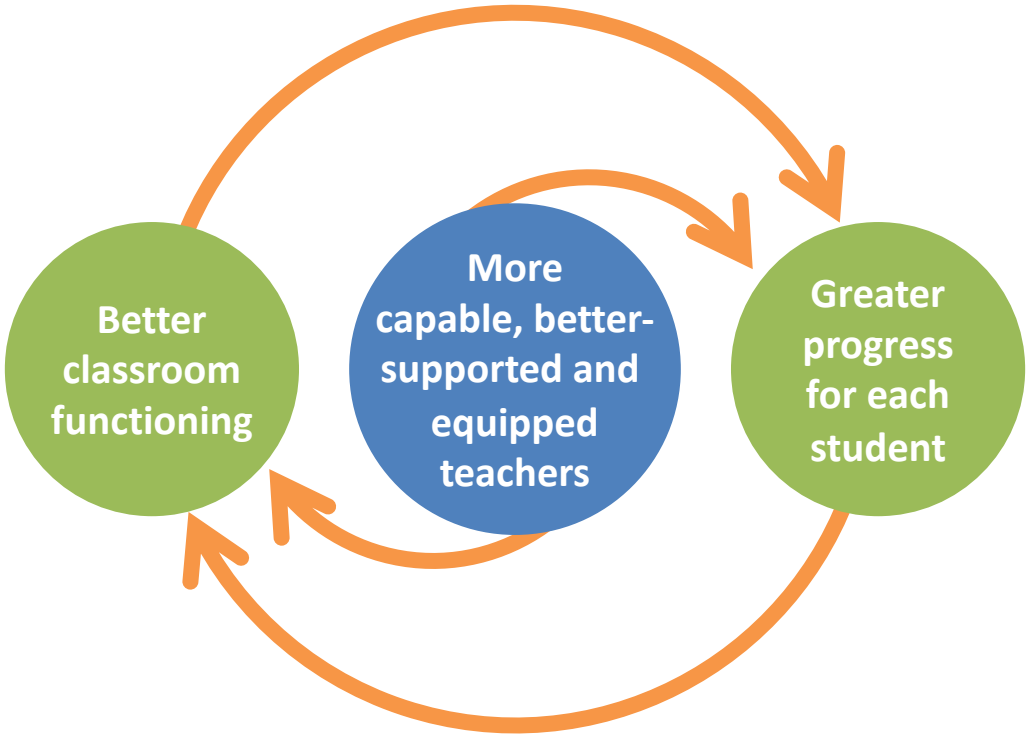
Children *exceeded* grade-level expectations

Closed the achievement gap: ELLs, minority, gender

Tools helps children reach their full potential by helping teachers achieve their own potential

Tools Empowers Teachers to Catalyze a Virtuous Cycle by focusing on Executive Functions

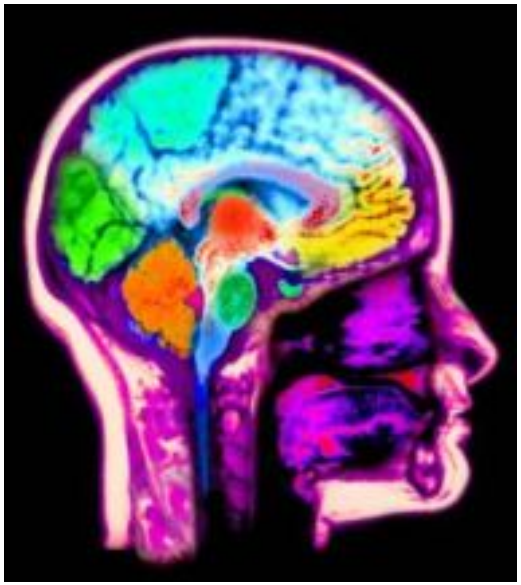
- Better classroom management
- Reduced behavioral challenges
- More time to tune into each child
- More satisfying teaching experience



- Focus on the development of Executive Functions
- Better assessment of 'Zone of Proximal Development' and scaffolding needs
- Support for peer interaction, cooperation and intentional play (enacting roles and stories)
- Better execution in providing appropriate scaffolding
- More engaged students
- Fewer "problem" children beyond teacher's capability to help

40

Neuroscience + Whole Child Development



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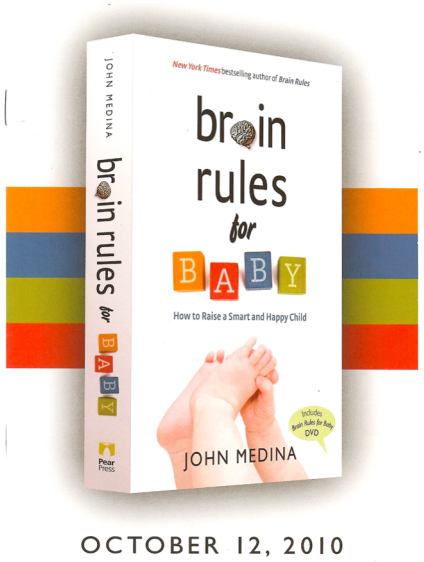

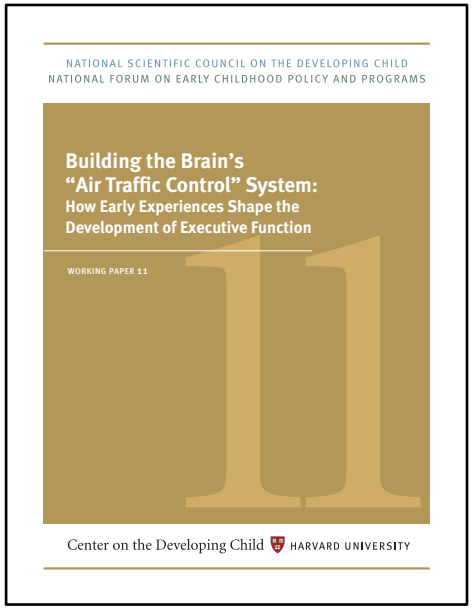

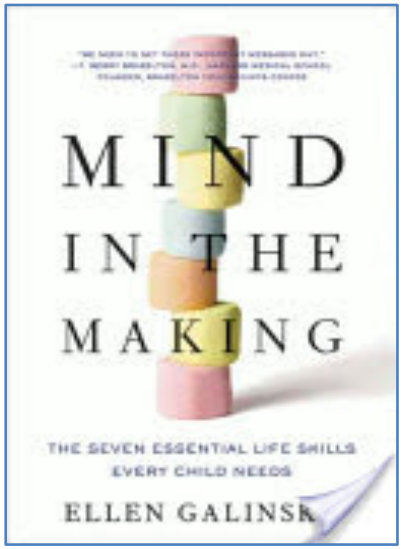

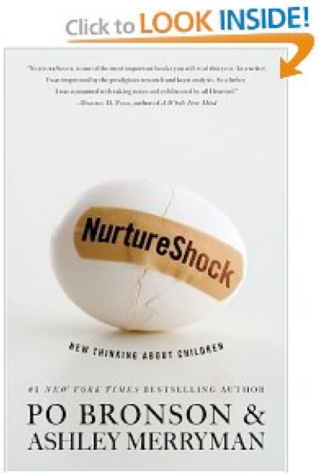

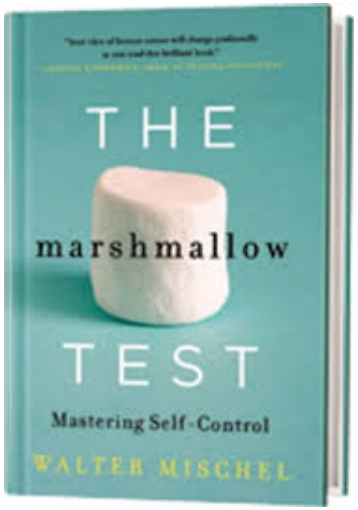

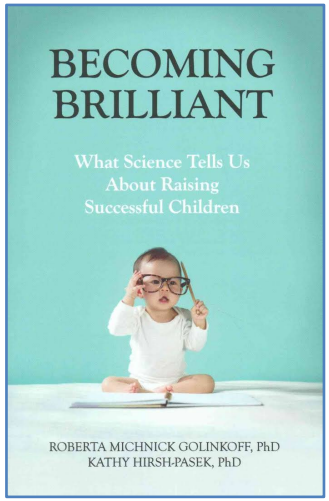

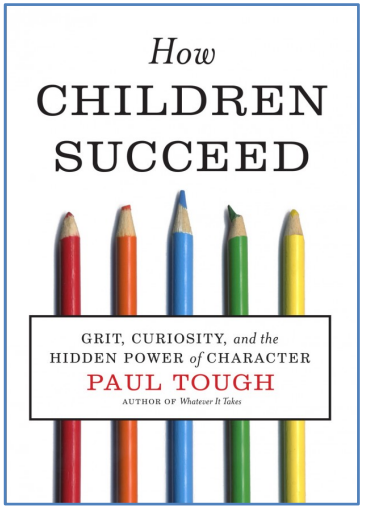

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