The Power of Play in Helping Young Children Develop Self-Regulation/Executive Functions

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Tools of the Mind™

NCLS Fellows Conference
September 18, 2017
www.toolsofthemind.org
Outline

- Tools of the Mind—An Intro
- Executive Functions (EFs)
  - Why do they matter?
  - What are they?
- How can we help children develop EFS?
  - The role of Play—Make-Believe Play
  - Embedding EFs practice in academic activities: Playful Learning, Teach planning, Provide practice
  - Design technology to support EFs practice
- Takeaways
Began as a faculty project in 1992 with one activity

Based on the developmental theory of learning and teaching (Vygotskian approach) and research on learning and teaching

A Pre-K and K program that are developmentally aligned

Serves about 500,000 primarily at-risk PreK-K children

www.toolsofthemind.org
Executive functions (EFs), also called cognitive control, are critical for success in school and life. Although EF skills are readily 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, acceptations, or distractions), (ii) working memory (internally holding and using information), and (iii) cognitive flexibility (adjusting to change) [1,2].

Significance
EFs are more strongly associated with school readiness than intelligence quotient (IQ) or entry-level reading or math skills [3–6]. Kindergarten teachers rank skills like self-discipline and attentional control as more critical for school readiness than content knowledge [7]. EFs are important for academic achievement throughout the school years. Working memory and inhibition independently predict math and reading achievement in middle school [7–9].

Many children begin school lacking in EF skills [10]. Teachers receive little instruction in how to improve EF and have preschoolers removed from class for poor self-control or alerting rates (5, 9). Previous attempts to improve children’s EFs 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 (1, 13). They fail progressively further behind in school each year (14).

The Study
The opportunity to evaluate the 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 to the second year of preschool (average age: 5.5 years in both) who received dill 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 dill with no self-selection into either curriculum. All came from low-income families (78% with yearly income <$25,000) [1].

After year 1, 2 were assigned in one school that Tools children were doing substantially better than dill, children told that the experiment is in fact school, exposing one sample of dill children. Measures of EF. Outcome measures (the Dros 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 (CF). They were administered in May and June of year 2.

In all conditions, the Dros task (26), a red heart or flower appeared on the right or left. In the cognitive conditions, one rule applied (press on the same side as the heart). Dros-discrepancy also required remembering and applying one of the side-specific executive functions, defined as horny, and inhibitory control are declarative achievements in children of lower middle class status [15,16]. Although a specific set of cognitive skills, executive functions seem to be continuously emphasized by attention and emotion for the EFs, executive functions can be in lower level neural systems and, physiologically, to the the executive functions is their capacity to be in the present in theory and research on claims of executive functions to reproduce. Changes in emotional self-regulation and the stereotypical strategies are accompanied by circulating levels of cortisol peptides, and the stereotypical strategies at high levels overwhelm the set of executive function.
Why Executive Functions Matter
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
EFs = 21st Century Skills

21st Century Skills

COGNITIVE
- Problem solving
- Critical thinking
- Systems thinking

INTERPERSONAL
- Communication
- Social skills
- Team-work
- Cultural sensitivity
- Dealing with diversity

INTRAPERSONAL
- Self-management
- Time management
- Self-development
- Self-regulation
- Adaptability
EFs and later success

- Higher self-control in early childhood, the higher income age 32,
- Low self-control in early childhood is associated with almost double the likelihood of criminal conviction by age 32
EFs = Emotion Regulation

- Influences peer relationships in short and long term and long-term mental health
- Influences the kind and quality of learning interactions in the classroom with teachers and peers
- Influences the child’s ability to handle the “stress of learning”
Stress can be toxic at any age. It rattles us when it strikes, shaking up our relationships and narrowing our focus. When it becomes chronic, it ravages our health. Physically, emotionally and intellectually, stress can drag us down.

An even more insidious effect is the assault it can launch on a child’s brain, impeding the development of critical cognitive skills. A number of researchers, including myself, have discovered that psychological stress affects the thinking skills and brain development of even very young children, likely beginning prenatally. It is no mystery that stress thrives in difficult situations, but research is now showing that a disadvantaged upbringing may set back children in profound, lasting ways. In fact, stress may be one important mechanism through which poverty adversely affects children’s ability to perform well in school.

Although children differ in their susceptibility to the problems of poverty, data show that youngsters from lower-income homes are very likely to start school behind their more affluent peers. This socioeconomic gap persists throughout the school years and is difficult to close. People have long argued that disadvantaged homes tend to offer an impoverished learning environment that does not sufficiently prepare children for the rigors of school. This theory is, at best, only half of the story. My work suggests that the stresses that accompany low income—such as crowded conditions, noise, financial worries and an inability to provide adequate child care—directly impair specific learning abilities in children.

A stressful childhood may emerge from conditions other than poverty, whether from challenging family circumstances such as a divorce.
What happens if children don’t develop EFs?

Children are at risk for:

- academic problems
- anti-social behavior
- eventual school drop out

(e.g., Trembley, et. al., 1999; Vitaro et al, 2006)
Lack of EFs is a Problem in Today’s Classroom

- Growing levels of aggression and oppositional behavior have been found in day care and Head Start (up to 1/3 of the class).
- 1 child out of every 40 preschool children is expelled from preschool over behavior problems.

(e.g., Kuperschmidt, Bryant, & Willoughby, 2000. Gilliam & Shahar 2006)
What the Research Says

- EF deficits are seen in a great many disorders, including Attention Deficit Hyperactivity Disorder

- The incidence of medicating children for poor inhibitory and attentional skills is increasing exponentially (400% more children were prescribed ADHD medication in 1999 than only 5 years before)

(e.g., Diamond, 2007)
What are Executive Functions?
Executive Functions

- Related to development of the prefrontal cortex
- A core process that influences both cognition and emotions
- Necessary for self-regulated behaviors
“Traffic Controller”

Executive Functions act as the “traffic controller” of the mind. It directs the mind’s action in an intentional way.

Without EFs, you just react to situations or act according to habit.
Components of Executive Function

- 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
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
Children read “Cat”
Working Memory

Ability to hold information “in mind”
Examples of 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
- Thinking about more than one perspective at the same time.

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

The boys’ arrows were nearly gone so they sat down on the grass and stopped hunting. Over at the edge of the woods, they saw Henry making a bow to a small girl who was coming down the road. She had tears in her dress and tears in her eyes. Does were standing at the edge of the lake, making an excellent target.
Cognitive Flexibility

Change and adjust mental effort
Examples of Cognitive Flexibility

- Flexibly changing tasks and moving back and forth between elements of a task.
- Paying more attention when a task or situation is more difficult. Investing more mental effort in tasks that are difficult.
Name the colors as quickly as you can. DO NOT read the words. SAY THE NAME OF THE COLOR.
Executive Function skills are necessary when you need to be intentional, to learn something new—on-purpose—when you are not functioning on autopilot.
How are your Executive Functions?

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The Development & Neural Bases of Cognitive Flexibility and Executive Function

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Hearts - Congruent

Push Left

Push Right

Flowers - Incongruent

Push Right

Push Left
Preschool Program Improves Cognitive Control

Adi Diamond, W. Steven Barnett, Jessica Thomas, Sarah Mavro

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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).

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Results
Cognitive control skills important for success in school and life are amenable to improvement in at-risk preschoolers without costly interventions. After year 1, so convinced were the educators in one school that children were doing substantially better than DBL children that they held the experiment in their school, reducing our sample of DBL children.

A hallmark of EF is the ability to inhibit inappropriate responses (16–20). Early preschool children suffer from a lack of inhibition (21–23). Two preschoolers engaged in a tool activity. The line drawing held by one guides her attention (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 side opposite the flower") plus it required inhibition of the tendency to respond on the side where the stimulus appeared. In Dots-Mixed, incongruent and congruent trials were intermixed (testing all three core EFs). Children were given a lot of time to respond (over five times as long as preschoolers usually take). The central stimulus for our flanker task was a circle or triangle. Memory demands were minimized by a triangle stop the right-hand key and at the bottom right of the screen, with similar aids for the left-hand circle response. The image to focus on was the small triangle in the center the distractor (or flanker) to be ignored was the larger shape surrounding it. Congruent (e.g., 0 inside 0) and incongruent (e.g., 0 inside 0) trials were intermixed. Next came "Reverse" Flanker, where children had to focus on the outside shape, inhibiting attention to the inside, plus flexibly switching.
Developmental trajectory of EF

Growth Spurts
3-7 years of age
15-25 years of age

Carlson, 2012
How can we help children develop Executive Functions?

Lessons from Tools of the Mind
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

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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
Cluster randomized controlled trial at the School level

12 districts, 29 schools, 79 classrooms, 725 children

Schools ranged from 3% to 92% free/reduced lunch eligible

Fall and Spring of K, follow-up in Fall of first grade

Blair & Raver, 2014
Evidence of Efficacy

Kindergarten end of the year results
• Children in Tools were significantly higher on mathematics and literacy

End of First Grade results
• No summer loss
• Sustained and growing effects on reading and vocabulary
Cortisol levels of children in at-risk classrooms were similar to those of children in middle class classrooms—showing an effect of mitigating “Toxic Stress” and boosting the physiology of “engagement”
Translational Science

www.developingchild.harvard.edu
How can we help children develop Executive Functions?

Use Intentional Make-Believe Play and Dramatization
Make-Believe Play

“The School for Self-Regulation” where children practice executive functions
Evidence that Make-Believe Play Increases Self-Regulation

Children were asked to stand still in 3 conditions:

- Experimenter asked the child to stand still
- Child was pretending to play the role of soldier
- Child was playing with peers and had the role of soldier
Number of minutes

Age

3 yrs 5 yrs 7 yrs

Role w/ Peers
Role only
Non-play

Manuilenko, 1948
Changes in the today’s culture of childhood mean less play at home—children come to school with less executive functions practice.
Mature Make-Believe Play

- Roles with rules and “role speech”
- Children voluntarily self-regulate
- Scenario changes and is planned in advance
- Symbolic props
- Deep engagement
NOT this kind of play
Dramatization
Kindergarten
Play Has Benefits Beyond Executive Function

- Link background knowledge to the story
- Recall complicated information
- Predict what happens next
- Visualize
- Explore plot and character
- Exploration of emotions
- Practice vocabulary
How can we help children develop Executive Functions?

Embed Executive Functions Practice in Academic Activities

Playful Learning

Teach Children How to Plan

Provide practice regulating learning
Playful Learning
Learning Games w/ Embedded EFs
One child has a "hand" and counts out the number of objects. The other child holds a picture of a "check" and checks the number of objects the first child counts out. The "checker" says "You have the right number!"
Executive Functions practice embedded in writing

Scaffolded Writing:
- Plan sentence in advance
- Draw a line for each word
- Write letters to stand for the word
- Reread

Lines help children to write with minimal adult support

Wooly Mammoths died in the warm weather. Paleontologists find Wooly Mammoth bones.
Gains Kindergarten

Aids Live Right Next To the Salamanders. And Live Above From the stalagmite.

Joshua

Jack and Annie were captured by a seal. Oysters are very very ruff on the outside. My oyster is as big as a new born baby. My oyster is almost as tall as the words.
Planning Play
Preschool

AYAN

*I AM GOING TO BE THE GONST

ERRIN

*Yo voy oral ser LER
estilo

SAUL

* I MEAN TO MARK CASTLE

3/16/09
# Planning Learning in Kindergarten

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What does cognitive self-regulation look like in a Tools kindergarten?
Peer-Regulated Learning

Can we build it?
How can we help children develop Executive Functions?

Design technology to support executive functions practice AND learning
The child chooses her reading level and a book to read in that level.

The content of the book regardless of the reading level is the same. The mini lesson and actual words in the text are set at an optimal decoding challenge for that child. This promotes equity in cooperative work as all children read the same content regardless of their reading ability.
Kindergarten PowerTools App

- Merges science and literacy instruction to support the development of scientific understandings AND build comprehension, vocabulary, decoding, and writing skills young children.

- Embeds Executive Functions practice in reading and science

- Increases the time spent, level of motivation, and effectiveness of decoding practice for beginning readers.

- Increases playful, focused learning and meaningful decoding practice. Decreases the over use of drill (& kill) and the use of ability grouping

- Scaffolds child reading errors, allowing the learner to control support

- Uses embedded, continuous, adaptive, personalized child assessment system to help teachers better sequence and improve instruction

- Enables parents regardless of reading skills to participate in the literacy instruction of their children that is aligned with what happens at school

- Based on research on learning, motivation, memory/attention, optimal feedback, and the neuroscience of reading/writing, etc.
Take Aways
Executive Functions matter!

- Early childhood is a critical period for interventions to increase self-regulation
- Self-regulation is LEARNED!!!
- Executive functions can be changed through classroom practices
EFs develop in the classroom and at home

- Teacher pre-service and in-service training should include development of and how to support executive functions
- Provide information to parents about how to develop executive functions
Classroom activities should simultaneously support EFs and learning
Make-believe play can help children develop the executive functions that contribute to achievement in school and in life.
If you’re interested in reading more you can visit our website or read about Tools of the Mind

www.toolsofthemind.org