Understanding Executive Functioning in Children

New Ideas, New Data, Effective Education and the Comprehensive Executive Functioning Inventory

Sam Goldstein, Ph.D.
Director, Neurology, Learning and Behavior Center, SLC, Utah

Assistant Clinical Professor
University of Utah, School of Medicine

www.samgoldstein.com
Relevant Disclosure

• Compensated speaker.
• Co-author Comprehensive Executive Functioning Scales.
• Co-author Cognitive Assessment System -2.
• Co-Editor Handbook of Executive Functioning.
• Co-author Practitioner’s Guide to Assessing Intelligence and Achievement.
• Editor in Chief JAD.
Goals for This Presentation

• Develop an initial understanding of the forces that drive human evolution and development with a focus on Executive Functioning (EF).
• Review the history, concepts and theories of EF relative to neuropsychology.
• Review EF research with various clinical groups.
• Focus upon the PASS theory and model developed by A. R. Luria.
• Discuss findings from the only nationally representative sample of youth to examine EF.
• Introduce the Comprehensive Executive Functioning Inventory (CEFI).
• Begin the process of modifying your mindsets about EF and remediation/strategic instruction.
EF’s First Citation?

In 1775 physician Melchior Adam Weikard published a medical textbook titled *Der Philosophische Arzt.*
Weikard wrote of *Attentio Volubilis* as people who possess a lack of attention, are careless, flighty, unwary and bacchanal.
Weikard wrote further:

“They are mostly reckless, imprudent in considering projects and reckless in execution. They treat everything in a light manner since they are not attentive enough to feel denigration or disadvantages”
The Curious Story of Phineas Gage

On September 18, 1848 an apparently capable, responsible and virile 25 year old foreman of a railroad construction crew named Phineas Gage, accidently dropped a 13 1/2 pound iron tamping rod on a dynamite charge.
The resulting explosion drove the rod through the left side of his face and out the top of the frontal portion of his cranium. He was taken to a nearby hotel which was to serve as his hospital room for 32 days when he was able to leave his bed.
The Curious Case of Phineas Gage

- He was eating and sleeping well.
- His long term memory appeared intact.
- He soon returned home 30 miles away.
- His health, general intelligence and memory appeared fine.
- However his behavior was so erratic that his employers soon dismissed him.
The Curious Case of Phineas Gage

• He behaved immaturely and impulsively.

• His physician H. M. Harlow wrote that his behavior was so radically different that his friends said he was “no longer Gage”.

• He died 12 years later in 1866 of what was reported to be a severe convulsion.
The Curious Case of Phineas Gage

- Alexander Luria wrote extensively about the functions of the frontal lobes.
- He noted that complex functions in these patients were significantly impaired yet basic functions remained intact.
- In writing about these executive function deficits he noted these patients were often unaware and unconcerned about their challenges.
This case and others spurred scientists in the mid 1800s to seek to develop an understanding of the frontal lobes in particular the pre-frontal cortex (PFC).
The idea of the PFC as the brain’s executer predates the concept of EF by at least 100 years.

John Harlow 1819 - 1907
In 1966 Luria first wrote and defined the concept of EF however he credited Bianchi (1895) and Bekhterev (1905) with the initial definition of the process.
Pribram in 1973 appeared to first coin the term EF to explain the workings of the PFC.

Karl Pribram
Executive Functioning (EF)

The ability to maintain an appropriate problem solving set for attainment of a future goal.  
(Welsh and Pennington 1988)
Is Executive Functioning an evidence based concept?
Executive functions - Wikipedia, the free encyclopedia
en.wikipedia.org/wiki/Executive_functions
The executive system is a theorized cognitive system in psychology that controls and manages other cognitive processes. It is responsible for processes that are ...
→ Neuroanatomy - Hypothesized role - Historical perspective - Development

What is Executive Function? - National Center for Learning Disabilities
www.ncld.org/...executive-functioning/.../what-is-executive-function
Dec 17, 2010 – Executive Function is a term used to describe a set of mental processes that helps us connect past experience with present action. We use ...

Executive function - effects, person, people, used, brain, personality ...
www.minddisorders.com › Del-Fi
The term executive function describes a set of cognitive abilities that control and regulate other abilities and behaviors. Executive functions are necessary for ...

Executive Function
www.chrisdendy.com/executive.htm
However, today's savvy parents and educators realize that deficits in critical cognitive skills known as executive functions (EF) are slower to mature in many ...

Executive Function Fact Sheet | LD Topics | LD OnLine
www.ldonline.org/article/24880/
Children use executive function to plan, organize, strategize, pay attention, manage details, and schedule themselves. Read this fact sheet from the National ...
EF is Becoming a Marketing Buzzword

Ads related to Executive Functioning tests

**Executive functioning tests** | lumosity.com
www.lumosity.com/
Improve Decision Making Skills with Scientifically Designed Brain Games
583 people +1'd Lumosity

* Improve intelligence - Create Free Account - Play Free Games

**Executive Functions** | Attengo.com
www.attengo.com/Executive_Function
Cost Effective Solution To Decrease ADHD & Improve Executive Functions!
EF is Becoming a Marketing Buzzword

Executive Function
Pearson offers assessments to evaluate higher level cognitive functions in both children and adults. Evaluate multi-tasking, cognition, and difficulties frequently associated with ADD and ADHD, as well as less apparent impairments related to executive functioning.

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The Dellis–Kaplan Executive Function System (D–KEFS) provides an evaluation of higher-level cognitive functions in children and adults.

FEATURED PRODUCT

Brown Attention-Deficit Disorder Scales® (BrownADDscales)
Brown Attention-Deficit Disorder Scales® (BrownADDscales) for a measure of ADD across the life span.

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Advanced Clinical Solutions for the WAIS®-IV and WMS®-IV
ACOS (Advanced Clinical Solutions) links the WAIS-IV and WMS-IV with assessments of executive functioning, social cognition, effort, and daily living skills. Premorbid functioning, malingering,
What is EF?

Absent in nearly all of the literature on EF may be any truly operational definition of the concept itself.

– One typically finds a vague general statement of EF (e.g., social intelligence, goal-directed action, cognitive control, top-down inhibition, effortful processing, etc.).

– Or a battery of tests believed to assess EF.

– Or a listing of the constructs subsumed by the term.

  Inhibition, Nonverbal and Verbal Working Memory, Planning, Problem-Solving, & Goal-Directed Activity, Strategy Development and Execution, Emotional Self-Regulation, Self-Motivation
Executive functions

From Wikipedia, the free encyclopedia

The executive system is a theorized cognitive system in psychology that controls and manages other cognitive processes. It is responsible for processes that are sometimes referred to as the executive function, executive functions, executive skills, supervisory attentional system, or cognitive control. These functions are largely carried out by prefrontal areas of the frontal lobe.

Executive function is an umbrella term for cognitive processes such as planning, working memory, attention, problem solving, verbal reasoning, inhibition, mental flexibility, multi-tasking, initiation and monitoring of actions.[1]
Scholarly articles for executive function therapy
... and metacognition: Innovative cognitive therapy, - Wells - Cited by 547
Behavior Rating Inventory of Executive Function (Adult ... - Arch - Cited by 66
... therapy improves cognition, mood, and function of ... - Meyers - Cited by 210

Cognitive Connections - Center for Executive Function Skill ...
www.executivefunctiontherapy.com/
We develop all aspects of executive function skills including time management,
attention, processing, organization, memory and problem solving using research ...

The Treatment of Executive Function Skills Using Equine Assisted ...
www.specialeducationadvisor.com/the-treatment-of-executive-functi...
Jan 9, 2011 – Equine Assisted Therapy (EAT) and Hippotherapy (HPOT) can be used in
the treatment of Executive Function problems. Therapists who utilize ...

Therapy for your CEO: Executive Function Therapy
www.brainline.org › TBI Topics › Diagnosing & Treating Brain Injury
What happens rehab like physical or occupational therapy come to an end for someone
with TBI.

[PDF] The Role of Executive Functions in Childhood Learning and Be...
www.lanfoundation.org/Docs/George%20McCloskey.pdf
File Format: PDF/Adobe Acrobat - Quick View
by G McCloskey - Cited by 1 - Related articles
How are executive functions related to intelligence? ... not include executive
functions as a distinct component to be ..... Cognitive Behavior Therapy. – OT/PT ...
Is Executive Functioning an evidence based concept?

- http://www.sharpbrains.com/teasers
- http://brain-training-games.net/
- http://www.lumosity.com/
- http://www.braingle.com
- http://www.braintraining101.com/braingames/
- http://www.freebraingames.com/
- http://www.brainmetrix.com/
- http://www.freebrainagegames.com/
- http://www.brainarena.com/
- http://www.setconnections.org/ExecutiveFunctionApps.html
A Bit More History

• Broadbent (1953): Automatic and controlled processes.
• Schiffrin and Schneider (1977): Controlled processes.
• Baddeley (1986): Central Executive as a component of working memory.
• Fuster, Banich, Cohen, Robbins, Knight and Stuss all offer related theories.
The neural mechanisms by which the EF is implemented is a topic of ongoing debate in the field of cognitive neuroscience. Traditionally, there has been a strong focus on the frontal lobes, but more recent brain research indicates that the EF system is far more distributed across the cortex.
A Bit of EF Neuroanatomy

- Prefrontal
- Rich cortical, sub-cortical and brain stem connections.
More Specifically:

- The dorsolateral prefrontal cortex (DLPFC) is involved with “on-line” processing of information such as integrating different dimensions of cognition and behavior. As such, this area has been found to be associated with verbal and design fluency, ability to maintain and shift set, planning, response inhibition, working memory, organizational skills, reasoning, problem solving and abstract thinking.
More Specifically:

- The anterior cingulate cortex (ACC) is involved in emotional drives, experience and integration. Associated cognitive functions include inhibition of inappropriate responses, decision making and motivated behaviors. Lesions in this area can lead to low drive states such as apathy and may also result in low drive states for such basic needs as food or drink and possibly decreased interest in social or vocational activities and sex.
And Finally:

• The orbitofrontal cortex (OFC) plays a key role in impulse control, maintenance of set, monitoring ongoing behavior and socially appropriate behaviors. The OFC also has roles in representing the value of rewards based on sensory stimuli and evaluating subjective emotional experiences. Lesions can cause disinhibition, impulsivity, aggressive outbursts, sexual promiscuity and antisocial behavior.
What Neural Activities Require EF?

- Those that involve planning or decision making.
- Those that involve error correction or troubleshooting.
- Situations when responses are not well-rehearsed or contain novel sequences of actions.
- Dangerous or technically difficult situations.
- Situations that require the overcoming of a strong habitual response or resisting temptation.
The EF system has been traditionally quite hard to define, mainly due to what psychologist Paul Burgess calls a lack of "process-behavior correspondence".
There is no single behavior that can in itself be tied to EF, or indeed executive dysfunction. For example, it is quite obvious what a reading-impaired child cannot do, but it is not so obvious what exactly EF impaired children might be incapable of doing.
Pennington and Ozonoff (1996) noted, “in both neuropsychology and cognitive psychology, the definition of EF is provisional and under-specified.”
Fletcher (1996) also acknowledged that EFs are difficult to define and described EFs as “factorially complex.”
Jurado and Rosselli (2007) acknowledged that the fundamental question of “whether there is one single underlying ability that can explain all the components of executive functioning or whether these components constitute related but distinct processes” remains unanswered.
EF is mainly concerned with the dynamic, efficient "online" co-ordination of cognitive resources. As such its’ effect can be observed only by measuring other cognitive processes. In a similar manner, it may not always fully engage outside of real-world situations.
As Antonio Damasio has observed, a patient with severe day-to-day EF problems may still pass paper-and-pencil or laboratory-based tests of EF.
Dimond (1980) argued there is a striking social pathology often overlooked associated with EF deficits.
Additionally, though many individuals with EF deficits possess limited awareness of their problems, are emotionally labile and impulsive, often aggressive in behavior, these qualities are difficult if not impossible to assess in laboratory settings with EF tests.
Luria noted “besides the disturbance of initiative and the other aforementioned behavioral disturbances almost all patients with a lesion of the frontal lobes have a marked loss of their critical faculty - i.e. a disturbance of their ability to correctly evaluate their own behavior and the adequacy of their actions.” (1966)
Theories of the executive system have been largely driven by observations of patients having suffered frontal lobe damage. They exhibited disorganized actions and strategies for everyday tasks (a group of behaviors now known as dysexecutive syndrome) although they seemed to perform normally when clinical or lab-based tests were used to assess more fundamental cognitive functions such as memory, learning language and reasoning. It was hypothesized that, to explain this unusual behavior, there must be an overarching system that co-ordinates other cognitive resources.
There are dozens of popular theories about EF. Most have only limited empirical support.
Miyake and Friedman’s Model of EF

Miyake and Friedman’s theory of executive functions proposes that there are three aspects of executive functions (EF): updating, inhibition, and shifting. A cornerstone of this theoretical framework is the understanding that individual differences in EF reflect both unity (i.e., common EF skills) and diversity of each component (e.g., shifting-specific). In other words, aspects of updating, inhibition, and shifting are related, yet each remains a distinct entity. First, updating is defined as the continuous monitoring and quick addition or deletion of contents within one’s working memory. Second, inhibition is one’s capacity to supersede responses that are pre-potent in a given situation. Third, shifting is one’s cognitive flexibility to switch between different tasks or mental states.
Executive Function

The Search for an Integrated Account

Marie T. Banich

Department of Psychology & Neuroscience, and Institute of Cognitive Science, University of Colorado at Boulder; Department of Psychiatry, University of Colorado Denver

ABSTRACT—In general, executive function can be thought of as the set of abilities required to effortlessly guide behavior toward a goal, especially in nonroutine situations. Psychologists are interested in expanding the understanding of executive function because it is thought to be a key process in intelligent behavior, it is compromised in a variety of psychiatric disorders, and it provides a mechanism for distinguishing or task irrelevant, switching between task goals, utilizing relevant information in support of decision making, categorizing or otherwise abstracting common elements across items, and handling novel information or situations. As can be seen from this list, the functions that fall under the category of executive function are indeed wide ranging.
Banich’s Cascade of Control Model

This model integrates theories from other models, and involves a sequential cascade of brain regions involved in maintaining attentional sets in order to arrive at a goal. In sequence, the model assumes the involvement of the posterior DLPFC, the mid-DLPFC, and the posterior and anterior dorsal ACC.
And Finally. . . .

An NICHD panel in 1994 identified 33 EFs by consensus!
The Top Six Were:

- Self-regulation
- Sequencing of behavior
- Flexibility
- Response inhibition
- Planning
- Organization of behavior
The Nature and Organization of Individual Differences in Executive Functions: Four General Conclusions

Akira Miyake\textsuperscript{1} and Naomi P. Friedman\textsuperscript{2}
\textsuperscript{1}Department of Psychology and Neuroscience, University of Colorado at Boulder and
\textsuperscript{2}Institute for Behavioral Genetics, University of Colorado at Boulder

Abstract

Executive functions (EFs)—a set of general-purpose control processes that regulate one’s thoughts and behaviors—have become a popular research topic lately and have been studied in many subdisciplines of psychological science. This article summarizes the EF research that our group has conducted to understand the nature of individual differences in EFs and their cognitive and biological underpinnings. In the context of a new theoretical framework that we have been developing (the unity/diversity framework), we describe four general conclusions that have emerged. Specifically, we argue that individual differences in EFs, as measured with simple laboratory tasks, (a) show both unity and diversity (different EFs are correlated yet separable), (b) reflect substantial genetic contributions, (c) are related to various clinically and societally important phenomena, and (d) show some developmental stability.
Miyake and Friedman suggest that all EFs as measured by laboratory tasks:

- Demonstrate unity and diversity;
- Reflect substantial genetic contribution;
- Are related to various clinical and social phenomena;
- Demonstrate some developmental stability.
Much of the experimental evidence for the neural structures involved in executive functions comes from laboratory tasks such as the Stroop or the Wisconsin Card Sorting.
Abstract

Ninety-two mixed etiology neurological patients and 216 control participants were assessed on a range of neuropsychological tests, including 10 neuropsychological measures of executive function derived from 6 different tests. People who knew the patients well (relatives or carers) completed a questionnaire about the patient's dysexecutive problems in everyday life, and this paper reports the extent to which the tests predicted the patients' everyday life problems. All of the tests were significantly predictive of at least some of the behavioral and cognitive deficits reported by patients' carers. However, factor analysis of the patients' dysexecutive symptoms suggested a fractionation of the dysexecutive syndrome, with neuropsychological tests loading differentially on 3 underlying cognitive factors (Inhibition, Intentionality, and Executive Memory), supporting the conclusions that different tests measure different cognitive processes, and that there may be limits to the fractionation of the executive system. (JINS, 1998, 4, 547–558.)
Executive functions are also needed to perform on such tasks, when relatively over learned and automatic behavior has to be inhibited in favor of a less practiced task.
EF is often invoked when it is necessary to override responses that might otherwise be automatically elicited by stimuli in the external environment. For example, on being presented with a potentially rewarding stimulus, such as a piece of cheesecake, a person might have the automatic response to take a bite. However, where such behavior conflicts with internal plans (such as having decided not to eat cake while dieting), EF might be engaged to inhibit that response.
Although suppression of these "pre-potent responses" is ordinarily considered adaptive, problems for the development of the individual and the culture arise when feelings of right and wrong are overridden by cultural expectations or when creative impulses are overridden by executive inhibitions.
A growing body of research demonstrates that bilinguals show advantages on tests of EF, specifically inhibitory control and task switching. A possible explanation for this is that speaking two languages requires controlling one's attention and choosing the correct language to speak. Across development, bilingual infants, children, and elderly show a bilingual advantage when it comes to EF task performance.
What is the relationship between EF and...

• Intelligence/Ability?
• Achievement/Knowledge?
• Self-regulation?
• Effort/Motivation?
• Socialization?
• Psychiatric Disorders?
• Adult Outcome?
• Performance?
Five Components of Performance
(Goldstein and Naglieri)

• Ability: The skills we use to acquire and manipulate knowledge to solve problems. Also referred to as intelligence.
• Knowledge: Everything we learn in life. Also referred to as achievement.
• Self-regulation: The capacity to slow down long enough to manipulate knowledge and ability.
• Motivation: The resilient mindset necessary to drive self-regulation. Also known as effort.
• Executive Function: The efficiency with which we go about solving problems, performing and relating.
A Multi-dimensional Model of Performance

- Ability
- Self-regulation
- Motivation
- Knowledge
- Executive Function
- Performance
Executive Function

“Broadly encompass a set of cognitive skills... (Working Memory, Inhibitory Control, Set Shifting, etc.)... that are responsible for the planning, initiation, sequencing, and monitoring of complex goal-directed (problem solving) behavior” (Royal et al., 2002).
Efficient Executive Functioning Requires:

1. An intention to act.
2. Formulation of a goal of action.
3. Formulation of a plan of action.
4. Temporally sequencing the chosen plan of action.
5. Executing the plan smoothly from step to step.
6. Evaluating and re-evaluating the outcome in light of the objective.
7. When successful move on – if failed rethink from step #3.
How can we reliably and validly evaluate EF?
What comprises the best means of assessment of EF?
The Stroop Color Word Test, Wisconsin Card Sorting Test, and Trail Making Test are the most commonly used measures of EF.
Some EF measures (e.g., Continuous Performance Test) are better at revealing between group differences than other EF measures (e.g., Tower of London).
EF and ADHD

EF deficits are not necessarily unique to ADHD. They are neither necessary nor sufficient to make a diagnosis of ADHD. When EF impairments are measured in children with ADHD they tend to reflect specific rather than global impairments.
EF and Other Disruptive Disorders (ODD & CD)

Earlier reviews reported that EF deficits were not characteristic of children and adolescents with ODD and CD after co-morbid ADHD was factored out. More recent studies, however, suggest that inhibition deficits may be characteristic of both ADHD and CD but whether children with CD display impairments on additional EF measures is equivocal.
EF and Tourette’s

Distinct and robust impairments in EF do not appear to be characteristic of children with TD.
EF and Anxiety Disorders

EF deficits in set-shifting, cognitive flexibility, concept formation, interference control, and verbal fluency have been documented among children with separation anxiety disorder, overanxious disorder, and PTSD. EF in OCD has not been well addressed.
EF and Depression

Scant research has been conducted on the EF abilities among youth with depression. Studies that have included older adolescents have suggested some degree of sensitivity of EF tasks in identifying unipolar depression, but less specificity.
There is a growing consensus about the nature of BD among children. Several studies have targeted its EF concomitants. Although results often have been confounded with significant co-morbidity issues, children and adolescents with BD reliably have demonstrated impairments relative to those without any history of mood disorders on several EF measures (e.g. working memory, set shifting).
EF and Learning Disabilities

• Planning deficits found in math disability.
• Attention and planning deficits found in ADHD.
• More research is needed.
A recent review by Weyandt et al (2012) found 168 measures used to evaluate EF.
<table>
<thead>
<tr>
<th>Executive Function Test</th>
<th>Number of Times Used</th>
<th>Sensitivity to Group Differences</th>
<th>Percentage of Significant Differences Between Clinical and Control Groups</th>
<th>Percentage of Significant Differences Between Two Clinical Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroop Color and Word Test and variants</td>
<td>41</td>
<td>28/73 = 38%</td>
<td>22/37 = 59%</td>
<td>6/36 = 17%</td>
</tr>
<tr>
<td>Wisconsin Card Sorting Test (including computerized and non-computerized versions)</td>
<td>34</td>
<td>75/226 = 33%</td>
<td>60/139 = 43%</td>
<td>14/88 = 16%</td>
</tr>
<tr>
<td>Trail Making Test and variants</td>
<td>26</td>
<td>43/121 = 36%</td>
<td>35/79 = 44%</td>
<td>8/42 = 19%</td>
</tr>
<tr>
<td>Continuous Performance Test and variants</td>
<td>19</td>
<td>31/72 = 43%</td>
<td>26/52 = 50%</td>
<td>5/15 = 33%</td>
</tr>
<tr>
<td>BRIEF</td>
<td>16</td>
<td>177/266 = 67%</td>
<td>88/104 = 85%</td>
<td>24/64 = 38%</td>
</tr>
<tr>
<td>Go/No-Go Test</td>
<td>14</td>
<td>37/81 = 46%</td>
<td>23/41 = 56%</td>
<td>7/17 = 41%</td>
</tr>
<tr>
<td>Tower of London test and Variants</td>
<td>13</td>
<td>3/75 = 4%</td>
<td>1/39 = 3%</td>
<td>2/39 = 5%</td>
</tr>
<tr>
<td>Rey-Osterith Complex Figure Test (ROCF) or Rey Complex Figure Test (RCFT)</td>
<td>12</td>
<td>31/93 = 33%</td>
<td>24/56 = 43%</td>
<td>7/37 = 19%</td>
</tr>
</tbody>
</table>

From Weyandt et al, 2012
EF tests are for the most part low to moderate in reliability and have some utility for identifying PFC injuries.
In general single EF tests share at most 10% of the variance with EF ratings and observations of everyday behavior.
Batteries of combined EF tests fare a bit better sharing up to 20% of the variance with observation and reported behavior.
The more tests in an EF battery the more factors identified in both exploratory and confirmatory studies.
The Delis-Kaplan Executive Functions System (D-KEFS) is an example of a battery approach to assessing EF.
NEPSY II

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NEPSY® - Second Edition (NEPSY® - II)
Author(s): Marit Korkman, Ph.D., Ursula Kirk, Ph.D., and Sally Kemp, Ph.D.

At a Glance:
Administration: General Assessment:
Preschool-ages - 45 minutes
School ages - 1 hour

Diagnostic & Selective Assessment: Will vary according to subtests, familiarity with procedures, child's presenting problems, etc.

Full Assessment:
Preschool-ages - 90 minutes
School ages - 2 to 3 hours

Scores: Standard (Scaled) Scores
Process Scores
Behavioral Observations

Software Available: Yes
Qualification level: C-Level
Publication Date: Now Available, 2007
Ages / Grades: 3 through 16 years
Norms: Nationally normed
Forms: Two Forms
Ages 3 through 4
Ages 5 through 16
The NEPSY-II is the only single measure that allows the clinician to create a tailored assessment across six domains, specific to a child's (ages 3:0-16:11 years) situation in order to answer referral questions or diagnostic concerns. The results provide information relating to typical childhood disorders, which can lead to accurate diagnosis and intervention planning for success in school and at home.
Delis-Kaplan Executive Functions System (D-KEFS)

This collection of neuropsychological tests is used to measure a variety of verbal and nonverbal EFs for children and adults (ages 8 – 89 years). This tool was developed over the span of a decade by Dean Delis, Edith Kaplan, and Joel Kramer, and was published in 2001. The D-KEFS comprises nine tests that were designed to stand alone. Therefore, there are no aggregate measures or composite scores for an examinee’s performance. A vast majority of these subtests are modified, pre-existing measures (e.g., the Trail Making Test), however, some of these measures reflect new indices of executive functions (e.g., Word Context Test).
The D-KEFS was normed with a representative sample. It has been reviewed to “hold much promise as a clinical and research tool (JCEN, 2005, 599-609). However the D-KEFS has been criticized because only 17% of the reliability values published in the D-KEFS manual are above a .80 value.
Problems With EF Tests

– EF tests have limited information on test-retest reliability; what exists is often in the low-moderate range. Limited norms and ceiling effects plague some measures (i.e., WCST).

– Low ecological validity: EF tests have low correlations with ratings of EF in natural settings (0-20% shared variance).

– Most EF tests were not developed to actually assess EF but were borrowed from other areas of non-EF research (CPTs in schizophrenia, etc.). The problem is with how to conceptualize EF rather than with construct validity of current tests.

– Most EF tests may be more sensitive to frank brain damage than to a more subtle developmental delay in EF as in ADHD.

– EF factor scores (latent constructs) may be better than individual test scores as indices of EF.
Are EF Rating Scales the Gold Standard?

- Measures real world behavior.
- Greater time window of assessment than tests.
- Able to sample multiple sources (self, parents, teachers).
- More cost-effective to obtain than tests.
- May be more highly associated with diagnostic conditions such as ADHD than tests.
- May be more predictive of impairments in major life activities.
Are EF Rating Scales the Gold Standard?

• However self-ratings may be less sensitive to EF deficits in people with EF deficits due to impaired self-awareness.

• Item pools are limited by how EF is defined and what Likert scaling anchor points are used to represent the scale (e.g. what is “Often”).
Importance of a National Norm

• The way we calibrate a psychological test or rating scale score has a direct impact on the reliability and validity of the instrument.

• The composition of the comparison and characteristics of the group is especially important whenever diagnostic decisions are being made.

• What is the current state of the art?
Importance of a National Norm

- What is the problem with not having a national norm?
  - You don’t know how typical children perform
    - Typical means a wide variety of individuals who vary on important demographic variables.

- What is the problem with not having a standard score like a T-score (mean of 50 and SD of 10)?
  - You don’t know how similar a child’s behavior is in relation to the norm.
Importance of a National Norm

– The diagnostic conclusions we reach are greatly influenced by the tools we use.
– The composition of the reference group can make a substantial difference in the conclusions reached.
– Norms that represent a typical population are needed for all assessment tools.
– We have an obligation to use the highest quality tests.
Importance of a National Norm

• Only tests that yield standard scores based on a representative normal sample should be used in clinical practice.
• A comparison of EF symptoms to a normative group is essential.
• Comparisons to children with symptoms of only EF deficits can be misleading.
• The use of raw scores should be avoided in all tests (especially achievement tests).
CEFI

The Comprehensive Executive Function Inventory (CEFI) is a rating scale designed to measure behaviors that are associated with Executive Function (EF) for children and youth aged 5 through 18 years. The rating scale can be completed by a parent, teacher, or the child/youth. The CEFI is composed of items related to attention, emotion regulation, flexibility, inhibitory control, initiation, organization, planning, self-monitoring, and working memory. The rating scale has been developed to demonstrate the highest psychometric qualities.
The normative sample characteristics were compared to the U.S. population (based on the 2009 American Community Survey of the U.S. Census Bureau) on race/ethnicity, parental education level (PEL), and geographic region. Of the parent ratings, 70.7% came from mothers, 25.4% from fathers, including adoptive mothers and fathers. The other 3.9% of ratings came from other guardians, including grandparents, aunts, and uncles. Teacher ratings came from educators that knew the student for a considerable amount of time (i.e., duration of student-teacher acquaintance: ≥ 12 months = 39.7%, 6–11 months = 48.3%, 1–5 months = 11.9%, < 1 months = 0.1%), and reported knowing the student quite well (i.e., teacher familiarity with the child: very well = 47.0%, moderately well = 52.8%, not very well = 0.2%).

The normative samples for the CEFI were collected using a stratified sampling plan based on the 2009 American Community Survey from the U.S. Census Bureau. Whereas age and gender were balanced across the normative samples, race/ethnicity and parental education level (PEL) represented the percentages of such demographic variables within the four U.S. Census regions (Northeast, Midwest, South, and West).
CEFI Norming

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>8</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>9</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>11</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>12</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>13</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>14</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>15</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>16</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>17</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>18</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>700</td>
<td>700</td>
</tr>
</tbody>
</table>
# CEFI Demographics

## Race/Ethnicity

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Total N</th>
<th>Total %</th>
<th>Census %</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic</td>
<td>308</td>
<td>22.0%</td>
<td>21.1%</td>
<td>-0.9%</td>
</tr>
<tr>
<td>Asian</td>
<td>56</td>
<td>4.0%</td>
<td>4.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Black</td>
<td>196</td>
<td>14.0%</td>
<td>13.9%</td>
<td>-0.1%</td>
</tr>
<tr>
<td>White</td>
<td>784</td>
<td>56.0%</td>
<td>56.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Other</td>
<td>56</td>
<td>4.0%</td>
<td>4.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1400</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td></td>
</tr>
</tbody>
</table>

## Region

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Total N</th>
<th>Total %</th>
<th>Census %</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>224</td>
<td>16.0%</td>
<td>17.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Midwest</td>
<td>309</td>
<td>22.1%</td>
<td>21.7%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>South</td>
<td>530</td>
<td>37.9%</td>
<td>37.2%</td>
<td>-0.6%</td>
</tr>
<tr>
<td>West</td>
<td>337</td>
<td>24.1%</td>
<td>24.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1400</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td>0.01%</td>
</tr>
</tbody>
</table>

## PEL

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Total N</th>
<th>Total %</th>
<th>Census %</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>No high school diploma</td>
<td>197</td>
<td>14.1%</td>
<td>14.7%</td>
<td>0.6%</td>
</tr>
<tr>
<td>High school diploma/GED</td>
<td>391</td>
<td>27.9%</td>
<td>28.5%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Some college or associate's degree</td>
<td>419</td>
<td>29.9%</td>
<td>28.9%</td>
<td>-1.0%</td>
</tr>
<tr>
<td>Bachelor's degree</td>
<td>252</td>
<td>18.0%</td>
<td>17.6%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>Graduate or professional degree</td>
<td>141</td>
<td>10.1%</td>
<td>10.3%</td>
<td>0.2%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1400</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td></td>
</tr>
</tbody>
</table>
CEFI Standardization

• Sample was stratified by
  – Sex, age, race/ethnicity, parental education level (PEL; for cases rated by parents), geographic region
  – Race/ethnicity of the child (Asian/Pacific Islander, Black/African American/African Canadian, Hispanic, White/Caucasian, Multi-racial by the rater
  – Parents provided PEL of both parents
    • The higher of the two levels was used to classify the parental education level of the child.
  – All raters completed the CEFI via the paper-and-pencil or online methods.
EXPLORATORY FACTOR ANALYSES

• Both item-level and scale-level exploratory factor analyses (EFA) were conducted.
• The normative samples for parents, teacher, and self ratings were randomly split into two samples and EFA conducted using
  – the item raw scores
  – nine scales’ raw scores
EXPLORATORY FACTOR ANALYSES

• For the first half of the normative sample using item scores: EFA of the 90 items was conducted
• The scree plot test and the very simple solution criterion both indicated that only one factor should be retained.
• The ratio of the first and second eigenvalues was greater than four for all three forms, which is a common rule to support a one factor solution.
EXPLORATORY FACTOR ANALYSES

• Using the second half of the normative sample EFA was conducted using raw scores for the Attention, Emotion Regulation, Flexibility, Inhibitory Control, Initiation, Organization, Planning, Self-Monitoring, and Working Memory scales

• Both the Kaiser rule (eigenvalues > 1) and the Eigenvalue Ratio criterion (> 4) unequivocally indicated one factor.
### Exploratory Factor Analyses

#### Table 8.4. Eigenvalues of the CEFI Scales Correlations

<table>
<thead>
<tr>
<th>Form</th>
<th>1st/2nd</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent</td>
<td>44.1</td>
<td>7.5</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>Teacher</td>
<td>28.2</td>
<td>7.8</td>
<td>0.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.1</td>
</tr>
<tr>
<td>Self Report</td>
<td>33.5</td>
<td>6.3</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.1</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

Note: Extraction method: Principal Axis Factoring.

#### Table 8.5. Scale Level Exploratory Factor Analysis One-Factor Solution

<table>
<thead>
<tr>
<th>Scale</th>
<th>Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parent</td>
</tr>
<tr>
<td>Attention</td>
<td>.941</td>
</tr>
<tr>
<td>Emotion Regulation</td>
<td>.846</td>
</tr>
<tr>
<td>Flexibility</td>
<td>.854</td>
</tr>
<tr>
<td>Inhibitory Control</td>
<td>.911</td>
</tr>
<tr>
<td>Initiation</td>
<td>.906</td>
</tr>
<tr>
<td>Organization</td>
<td>.933</td>
</tr>
<tr>
<td>Planning</td>
<td>.968</td>
</tr>
<tr>
<td>Self Monitoring</td>
<td>.935</td>
</tr>
<tr>
<td>Working Memory</td>
<td>.904</td>
</tr>
</tbody>
</table>
Our conclusion to the critical question: Is it Executive Function or Functions?
CEFI data based on ratings by parents and teachers clearly supports the view that Executive Function better defines this concept.
(5–18 Years)
PARENT FORM
Jack A. Naglieri, Ph.D. & Sam Goldstein, Ph.D.

<table>
<thead>
<tr>
<th>Child's Name/I.D.</th>
<th>Today's Date:</th>
<th>Year</th>
<th>Month</th>
<th>Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender: M</td>
<td>F</td>
<td>Birth Date:</td>
<td>Year</td>
<td>Month</td>
</tr>
<tr>
<td>(Circle One)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade:</td>
<td>Age:</td>
<td></td>
<td>Years</td>
<td>Months</td>
</tr>
<tr>
<td>Parent's Name/I.D.</td>
<td>School:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship to Child:</td>
<td>Examiner:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CEFI

Comprehensive Executive Function Inventory Forms

CEFI (5–18 Years) Parent Ratings
CEFI (5–18 Years) Teacher Ratings
CEFI (12–18 Years) Self-Report Ratings

Age Range: 5–18 Years
Number of Items: 100

Age Range: 12–18 Years
Number of Items: 100

Full Scale

CEFI Scales
- Attention
- Emotion Regulation
- Flexibility
- Inhibitory Control
- Initiation
- Organization
- Planning
- Self-Monitoring
- Working Memory
Uses of the CEFI

Assessing an Individual

The CEFI can be used during the assessment and the diagnostic process. Standardized scores from the CEFI allow the clinician to effectively compare an individual to a nationally representative norm group. The scores can be integrated with other information to form a more complete understanding of the individual. When used in combination with other assessment information, results from the CEFI help in guiding diagnostic decisions, treatment planning, and ongoing monitoring of treatment progress. The CEFI can also be used to evaluate the effectiveness of a treatment program for a child with EF deficits.

Screening a Group of Individuals

In some instances, the assessor may wish to obtain information about a group instead of an individual. A school setting is one example, where the CEFI can be used to screen a group of children to determine those who might require a full evaluation, or to identify those who might benefit from additional support. Low scores suggest that additional considerations are needed, such as further examination, a more thorough evaluation, and/or some treatment to modify troubling behaviors.

Evaluating an Intervention Program

Results from the CEFI can inform decisions about the effectiveness of a particular individual or group intervention. When used in a clinical setting, CEFI results can be collected at the beginning of an intervention and at several points throughout the intervention, in order to evaluate whether a particular program is associated with behavioral improvement. In research studies, group data from the CEFI can be analyzed to determine whether change (pre-versus post-treatment, or experimental treatment versus control group) is significant. Results from these types of evaluations can be helpful in supporting the continuation of a treatment program or line of research.

Use in a Research Context

The CEFI can be used by researchers in a variety of settings and for different research protocols. The CEFI offers researchers several different advantages. First, the scales were carefully developed to measure a wide spectrum of behaviors associated with EF. Second, the scales provide scores based upon a nationally representative normative sample (aged 5 to 18 years) of a diverse group of individuals. Third, the CEFI scales have good reliability and validity. Fourth, the CEFI has strong psychometric qualities, which are well documented in this manual. Fifth, the CEFI is easily compared to other instruments due to the availability of standard scores.
CEFI Options

CEFI Forms
As illustrated in Figure 1.1, the CEFI is a full-length form for children and youth, aged 5 to 18 years. The CEFI comprises 100 items. There are separate parent (CEFI [5–18 Years] Parent Ratings), teacher (CEFI [5–18 Years] Teacher Ratings), and self-report (CEFI [12–18 Years] Self-Report Ratings) rating forms; however, the self-report form applies only to the 12 to 18 years age group. Parent, teacher, and self-report forms are also available in Spanish. All scales are set to have a normative mean of 100 and standard deviation of 15.

Paper-and-Pencil Administration and Scoring
All of the CEFI forms are available in the MHS QuikScore™ format. The rater writes on the external layers of the form, and the results transfer through to a hidden scoring grid within the internal layers. The assessor then uses the internal layers to tabulate results. Each CEFI QuikScore form includes conversion tables, which are used to transform raw scores to standard scores and percentile ranks. For individuals who wish to use software or online scoring, CEFI items are also available as response forms that do not include the scoring pages. For further details about administering and scoring the CEFI paper forms, see chapter 3.

Online Administration and Scoring
The CEFI can be completed and automatically scored online wherever an internet connection is available. Paper-and-pencil forms can also be scored online by entering responses from a completed paper-and-pencil administration into the online program. Further information about online administration and scoring is provided in chapter 3.

Software Scoring
All CEFI forms can be scored using the MHS Scoring Software by entering responses from a completed paper-and-pencil administration into the software program. See chapter 3 for further details regarding software scoring.
CEFI Administration and Scoring

**Administrative and Scoring Options**

- **Paper-and-Pencil Administration**
  - Rater completes the CEFI in a Response Booklet or QuikScore™ Form.

- **Paper-and-Pencil Scoring**
  - Examiner separates pages of the QuikScore form and calculates scores directly on the form.

- **Software Scoring**
  - Examiner enters responses into CEFI Scoring Software for automatic scoring and report generating.

- **Online Scoring**
  - Examiner enters responses into MHS Online Assessment Center for automatic scoring and report generating.

- **Online Scoring**
  - CEFI is scored automatically and reports are generated online.
<table>
<thead>
<tr>
<th>Scale</th>
<th>Interpretive Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale</td>
<td>Reflects overall executive function. The Full Scale score is made up ninety executive function behaviors that are rationally assigned to nine CEFI Scales (i.e., Attention, Emotion Regulation, Flexibility, Inhibitory Control, Initiation, Organization, Planning, Self-Monitoring, and Working Memory) The CEFI Scales describe the content of the items for intervention purposes. If there is significant variation among the CEFI Scales, the Full Scale score will sometimes be higher and other times lower than scores on these scales. However, the Full Scale score is a good description of a child’s executive function behaviors if there is no significant variation among the CEFI Scales.</td>
</tr>
<tr>
<td>Attention</td>
<td>Describes how well a child can avoid distractions, concentrate on tasks, and sustain attention.</td>
</tr>
<tr>
<td>Emotion Regulation</td>
<td>Indicates control and management of emotions, including staying calm when handling small problems and reacting with the right level of emotion.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Reflects how well a child adjusts his/her behavior to meet circumstances, including coming up with different ways to solve problems, having many ideas about how to do things, and being able to solve problems using different approaches.</td>
</tr>
<tr>
<td>Inhibitory Control</td>
<td>Describes the ability to control behavior or impulses, including thinking about consequences before acting, maintaining self-control, and keeping commitments.</td>
</tr>
<tr>
<td>Initiation</td>
<td>Indicates how a child begins tasks or projects on his/her own, including starting tasks easily, being motivated, and taking the initiative when needed.</td>
</tr>
<tr>
<td>Organization</td>
<td>Reflects the ability to manage personal effects, work, or multiple tasks, including organizing tasks and thoughts well, managing time effectively, and working neatly.</td>
</tr>
<tr>
<td>Planning</td>
<td>Describes how well a child can develop and implement strategies to accomplish tasks, including planning ahead and making good decisions.</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td>Indicates the ability a child has to evaluate his/her own behavior in order to determine when a different approach is necessary, including noticing and fixing mistakes, knowing when help is required, and understanding when a task is completed.</td>
</tr>
<tr>
<td>Working Memory</td>
<td>Reflects how well a child can keep information in mind that is important for knowing what to do and how to do it, including remembering important things, instructions, and steps.</td>
</tr>
</tbody>
</table>
## Ipsative values

| Level of Significance | Parent Form | | Teacher Form | | Self-Report Form | |
|-----------------------|-------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|                       | 5-11 Years  | 12-18 Years                | 5-11 Years                 | 12-18 Years                 | 12-18 Years                 |
| Attention             | 9.1         | 7.6                        | 8.5                        | 7.1                        | 6.6                        |
| Emotional Regulation  | 11.0        | 9.3                        | 10.0                       | 8.4                        | 8.4                        |
| Flexibility           | 12.3        | 10.3                       | 11.8                       | 9.9                        | 9.9                        |
| Inhibitory Control    | 10.6        | 8.9                        | 10.0                       | 8.4                        | 8.0                        |
| Initiation            | 10.9        | 9.1                        | 10.0                       | 8.4                        | 8.8                        |
| Organization          | 10.3        | 8.7                        | 9.0                        | 7.5                        | 8.3                        |
| Planning              | 9.6         | 8.0                        | 8.7                        | 7.3                        | 7.2                        |
| Self Monitoring       | 11.9        | 10.0                       | 10.5                       | 8.8                        | 9.4                        |
| Working Memory        | 10.8        | 9.1                        | 10.2                       | 8.5                        | 7.8                        |
## Quality of Ratings

<table>
<thead>
<tr>
<th>Scale</th>
<th>Interpretive Text</th>
<th>Interpretive Text</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consistency Index</strong></td>
<td>The rater responded in a different way to similar items. This rating pattern is not typical and should be further investigated.</td>
<td>The pattern of ratings is typical.</td>
</tr>
<tr>
<td><strong>Negative Impression Scale</strong></td>
<td>The pattern of ratings may underestimate the child’s behavior. This rating pattern is not typical and should be further investigated.</td>
<td>The pattern of ratings is typical.</td>
</tr>
<tr>
<td><strong>Positive Impression Scale</strong></td>
<td>The pattern of ratings may overestimate the child’s behavior. This rating pattern is not typical and should be further investigated.</td>
<td>The pattern of ratings is typical.</td>
</tr>
<tr>
<td><strong>Time to Completion</strong></td>
<td>The rater spent considerably less time than is usual completing the CEFI.</td>
<td>The time the rater took to complete the CEFI was typical.</td>
</tr>
</tbody>
</table>
### Table 5.3. CEFI Negative Impression Scale and Positive Impression Scale Items

<table>
<thead>
<tr>
<th>Negative Impression Scale</th>
<th>Positive Impression Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Item</td>
</tr>
<tr>
<td>2. have good thoughts about everyone? (R)</td>
<td>2. have good thoughts about everyone?</td>
</tr>
<tr>
<td>20. only care about what is best for others? (R)</td>
<td>20. only care about what is best for others?</td>
</tr>
<tr>
<td>24. get bothered by something?</td>
<td>24. get bothered by something? (R)</td>
</tr>
<tr>
<td>33. have a bad day?</td>
<td>33. have a bad day? (R)</td>
</tr>
<tr>
<td>46. do things the wrong way?</td>
<td>46. do things the wrong way? (R)</td>
</tr>
<tr>
<td>54. get embarrassed?</td>
<td>54. get embarrassed? (R)</td>
</tr>
<tr>
<td>61. do things perfectly? (R)</td>
<td>61. do things perfectly?</td>
</tr>
<tr>
<td>66. like everyone he/she met? (R)</td>
<td>66. like everyone he/she met?</td>
</tr>
<tr>
<td>77. know the right answer? (R)</td>
<td>77. know the right answer?</td>
</tr>
<tr>
<td>95. get upset?</td>
<td>95. get upset? (R)</td>
</tr>
</tbody>
</table>

**Note.** (R) = Reverse scored item.
Mean Raw Scores by Age

Figure 6.1. Mean Raw Scores by Age and Rater: CEFI Full Scale

- CEFI Parent
- CEFI Teacher
- CEFI Self Report
<table>
<thead>
<tr>
<th>Scale</th>
<th>Interpretive Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale</td>
<td>Reflects overall executive function. The Full Scale score is made up ninety executive function behaviors that are rationally assigned to nine CEFI Scales (i.e., Attention, Emotion Regulation, Flexibility, Inhibitory Control, Initiation, Organization, Planning, Self-Monitoring, and Working Memory) The CEFI Scales describe the content of the items for intervention purposes. If there is significant variation among the CEFI Scales, the Full Scale score will sometimes be higher and other times lower than scores on these scales. However, the Full Scale score is a good description of a child’s executive function behaviors if there is no significant variation among the CEFI Scales.</td>
</tr>
<tr>
<td>Attention</td>
<td>Describes how well a child can avoid distractions, concentrate on tasks, and sustain attention.</td>
</tr>
<tr>
<td>Emotion Regulation</td>
<td>Indicates control and management of emotions, including staying calm when handling small problems and reacting with the right level of emotion.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Reflects how well a child adjusts his/her behavior to meet circumstances, including coming up with different ways to solve problems, having many ideas about how to do things, and being able to solve problems using different approaches.</td>
</tr>
<tr>
<td>Inhibitory Control</td>
<td>Describes the ability to control behavior or impulses, including thinking about consequences before acting, maintaining self-control, and keeping commitments.</td>
</tr>
<tr>
<td>Initiation</td>
<td>Indicates how a child begins tasks or projects on his/her own, including starting tasks easily, being motivated, and taking the initiative when needed.</td>
</tr>
<tr>
<td>Organization</td>
<td>Reflects the ability to manage personal effects, work, or multiple tasks, including organizing tasks and thoughts well, managing time effectively, and working neatly.</td>
</tr>
<tr>
<td>Planning</td>
<td>Describes how well a child can develop and implement strategies to accomplish tasks, including planning ahead and making good decisions.</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td>Indicates the ability a child has to evaluate his/her own behavior in order to determine when a different approach is necessary, including noticing and fixing mistakes, knowing when help is required, and understanding when a task is completed.</td>
</tr>
<tr>
<td>Working Memory</td>
<td>Reflects how well a child can keep information in mind that is important for knowing what to do and how to do it, including remembering important things, instructions, and steps.</td>
</tr>
</tbody>
</table>
Figure 4.1. Illustration of Executive Function Weakness and Strengths on the CEFI (5-18 Years) Teacher Form

<table>
<thead>
<tr>
<th>CEFI Scales</th>
<th>Standard Score</th>
<th>Difference From Youth’s Average</th>
<th>Statistically Significant? (Yes/No)</th>
<th>Executive Function Strength/Weakness</th>
<th>90%/95% (circle one) Confidence Interval</th>
<th>Percentile Rank</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention (AI)</td>
<td>95</td>
<td>-6.7</td>
<td>Yes</td>
<td></td>
<td>[90 to 100]</td>
<td>37</td>
<td>Average</td>
</tr>
<tr>
<td>Emotion Regulation (ER)</td>
<td>82</td>
<td>-19.7</td>
<td>Yes</td>
<td>Weakness</td>
<td>[77 to 90]</td>
<td>12</td>
<td>Low Average</td>
</tr>
<tr>
<td>Flexibility (FX)</td>
<td>112</td>
<td>10.3</td>
<td>Yes</td>
<td>Strength</td>
<td>[103 to 118]</td>
<td>79</td>
<td>High Average</td>
</tr>
<tr>
<td>Inhibitory Control (IC)</td>
<td>99</td>
<td>-2.7</td>
<td>No</td>
<td></td>
<td>[93 to 105]</td>
<td>47</td>
<td>Average</td>
</tr>
<tr>
<td>Initiation (IT)</td>
<td>120</td>
<td>18.3</td>
<td>Yes</td>
<td>Strength</td>
<td>[112 to 125]</td>
<td>91</td>
<td>Superior</td>
</tr>
<tr>
<td>Organization (OG)</td>
<td>99</td>
<td>-2.7</td>
<td>No</td>
<td></td>
<td>[93 to 105]</td>
<td>47</td>
<td>Average</td>
</tr>
<tr>
<td>Planning (PL)</td>
<td>101</td>
<td>-0.7</td>
<td>No</td>
<td></td>
<td>[96 to 106]</td>
<td>53</td>
<td>Average</td>
</tr>
<tr>
<td>Self-Monitoring (SM)</td>
<td>102</td>
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<tr>
<td>Working Memory (WM)</td>
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<td>3.3</td>
<td>No</td>
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<td>[99 to 111]</td>
<td>63</td>
<td>Average</td>
</tr>
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</table>

Note: Differences from the Youth’s Average significant at $p < .10$
## Sample Scores

<table>
<thead>
<tr>
<th>CEFI Scales</th>
<th>Standard Score</th>
<th>Difference From Youth's Average</th>
<th>Statistically Significant? (Yes/No)</th>
<th>Executive Function Strength/Weakness</th>
<th>90% to 95% Confidence Interval</th>
<th>Percentile Rank</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
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<td>95</td>
<td>-6.7</td>
<td>Yes</td>
<td>Weakness</td>
<td>90 to 100</td>
<td>37</td>
<td>Average</td>
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<tr>
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<td>82</td>
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<td>Yes</td>
<td></td>
<td>77 to 90</td>
<td>12</td>
<td>Low Average</td>
</tr>
<tr>
<td>Flexibility (FX)</td>
<td>112</td>
<td>10.3</td>
<td>Yes</td>
<td>Strength</td>
<td>103 to 118</td>
<td>79</td>
<td>High Average</td>
</tr>
<tr>
<td>Inhibitory Control (IC)</td>
<td>99</td>
<td>-2.7</td>
<td>No</td>
<td></td>
<td>93 to 105</td>
<td>47</td>
<td>Average</td>
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<tr>
<td>Initiation (IT)</td>
<td>120</td>
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<td>Yes</td>
<td>Strength</td>
<td>112 to 125</td>
<td>91</td>
<td>Superior</td>
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<tr>
<td>Organization (OG)</td>
<td>99</td>
<td>-2.7</td>
<td>No</td>
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<td>93 to 105</td>
<td>47</td>
<td>Average</td>
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<tr>
<td>Planning (PL)</td>
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<td>53</td>
<td>Average</td>
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<td>Self-Monitoring (SM)</td>
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<td>55</td>
<td>Average</td>
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<tr>
<td>Working Memory (WM)</td>
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<td>99 to 111</td>
<td>63</td>
<td>Average</td>
</tr>
</tbody>
</table>

| Sum of Standard Scores       | 915            | 101.7                            | Youth's Average                    |                                     |                                 |                 |                   |

*Note. Differences from the Youth's Average significant at p < .10*
## Critical Differences Between Raters

<table>
<thead>
<tr>
<th>Age Group (Years)</th>
<th>Parent to Parent</th>
<th>Teacher to Teacher</th>
<th>Parent to Teacher</th>
<th>Parent to Self-Report</th>
<th>Teacher to Self-Report</th>
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<td>12-18</td>
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<td>11</td>
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</tr>
<tr>
<td>Working Memory</td>
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<td>11</td>
<td>11</td>
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### Critical Values for Change Over Time

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<tr>
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<td>12-18 Years</td>
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<td><strong>Full Scale</strong></td>
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<td><em>p &lt; .05</em></td>
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<td>4</td>
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<td>6</td>
<td></td>
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<td><strong>CEFI Scales</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>Attention</td>
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<td>10</td>
<td>9</td>
<td>7</td>
<td>16</td>
<td>13</td>
</tr>
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<td>10</td>
<td>20</td>
<td>17</td>
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<tr>
<td>Flexibility</td>
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<td>14</td>
<td>14</td>
<td>12</td>
<td>20</td>
<td>17</td>
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<td>12</td>
<td>14</td>
<td>12</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>Initiation</td>
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<td>14</td>
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<td>14</td>
<td>12</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>Working Memory</td>
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<td>13</td>
<td>14</td>
<td>12</td>
<td>18</td>
<td>15</td>
</tr>
</tbody>
</table>
Validity of the Factors

• Factor analysis is a valuable tool to understand how items group.
• But we also need to know if the items have validity.
• Discriminating children with EF deficits from the regular population is important.
• Discriminating children with EF deficits from those who are not in the regular population and have other problems is very important.
## Constructs Operationalized: CEFI vs. BRIEF

<table>
<thead>
<tr>
<th></th>
<th>CEFI</th>
<th>BRIEF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attention</strong></td>
<td>Having a state of awareness that prepares CNS for selective focus on specific stimuli</td>
<td>Emotional Control: Modulate emotional responses/mood appropriately</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Ability to respond appropriately to changing or altered situations or different people/circumstances</td>
<td>Shift: Transition smoothly between or adapt to new activities/situations; problem-solve flexibly</td>
</tr>
<tr>
<td><strong>Impulse Control</strong></td>
<td>Restraining impulses, reactions, or behavior</td>
<td>Inhibit: Control, delay or stop impulses/behavior</td>
</tr>
<tr>
<td><strong>Initiate</strong></td>
<td>Willing exertion of physical or mental effort in pursuit of a goal</td>
<td>Initiate: Begin activity; generate ideas; start new tasks</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>Ability to store, retain, manipulate, &amp; recall information</td>
<td>Working Memory: Hold information in mind to complete a task/sustain focus</td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>Applying a structure or system for arranging or classifying objects &amp; tasks; methodical and efficient behavior</td>
<td>Organization of Materials: Clean up after oneself</td>
</tr>
<tr>
<td><strong>Planning</strong></td>
<td>Holding a mental representation of intended action that guides behavior; outline of steps to complete a task/solve a problem</td>
<td>Plan/Organize: Anticipate future events; set goals; develop steps; grasp main ideas; think prospectively; follow a plan</td>
</tr>
<tr>
<td><strong>Self/Performance Monitoring</strong></td>
<td>Ability to attend to &amp; evaluate ongoing behavior/outcomes to make necessary corrections for successful goal completion</td>
<td>Monitor: Check work; assess performance; monitor effect of behavior on others</td>
</tr>
</tbody>
</table>
## CEFI vs. BRIEF

<table>
<thead>
<tr>
<th>Form</th>
<th>Obtained $r$</th>
<th>Corrected $r$</th>
<th>$N$</th>
<th>CEFI Full Scale</th>
<th>BRIEF Global Executive Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Parent</td>
<td>.76</td>
<td>.82</td>
<td>110</td>
<td>82.9</td>
<td>12.3</td>
</tr>
<tr>
<td>Teacher</td>
<td>.75</td>
<td>.64</td>
<td>106</td>
<td>89.2</td>
<td>12.5</td>
</tr>
<tr>
<td>Self Report</td>
<td>.79</td>
<td>.66</td>
<td>62</td>
<td>93.3</td>
<td>17.3</td>
</tr>
</tbody>
</table>

*Note.* All correlations significant, $p < .01$. Pair-wise deletion of missing cases was used; Obt. $r =$ Obtained $r$; Cor. $r =$ Corrected $r$; Converted Scores = BRIEF scores inverted and rescored to compare to CEFI (normative $M = 100$ and $SD = 15$); Original scores = Brief $T$-Scores (normative $M = 50$ and $SD = 10$).
# CEFI vs. BRIEF

<table>
<thead>
<tr>
<th>Form</th>
<th>Obtained $r$</th>
<th>Corrected $r$</th>
<th>$N$</th>
<th>CEFI Full Scale $M$</th>
<th>SD</th>
<th>BRIEF Global Executive Composite Converted Scores $M$</th>
<th>SD</th>
<th>Original Scores $M$</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent</td>
<td>.76</td>
<td>.85</td>
<td>57</td>
<td>81.9</td>
<td>11.7</td>
<td>71.8</td>
<td>13.7</td>
<td>68.8</td>
<td>9.1</td>
</tr>
<tr>
<td>Teacher</td>
<td>.69</td>
<td>.64</td>
<td>51</td>
<td>87.4</td>
<td>11.1</td>
<td>71.2</td>
<td>23.7</td>
<td>69.2</td>
<td>15.8</td>
</tr>
<tr>
<td>Self-Report</td>
<td>.68</td>
<td>.68</td>
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<td>90.2</td>
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<td>86.7</td>
<td>15.9</td>
<td>58.8</td>
<td>10.6</td>
</tr>
</tbody>
</table>

*Note.* All correlations significant, $p < .01$. Pair-wise deletion of missing cases was used; Obt. $r =$ Obtained $r$; Cor. $r =$ Corrected $r$; Converted Scores = BRIEF scores inverted and rescored to compare to CEFI (normative $M = 100$ and $SD = 15$); Original scores = Brief $T$-Scores (normative $M = 50$ and $SD = 10$).
# CEFI vs. BRIEF

<table>
<thead>
<tr>
<th>Form</th>
<th>Obtained $r$</th>
<th>Corrected $r$</th>
<th>$N$</th>
<th>CEFI Full Scale</th>
<th>BRIEF Global Executive Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Parent</td>
<td>.77</td>
<td>.78</td>
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</tr>
<tr>
<td>Teacher</td>
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<td>.66</td>
<td>55</td>
<td>90.8</td>
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<td>Self-Report</td>
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<td>.63</td>
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<td>96.6</td>
<td>19.7</td>
</tr>
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</table>

**Note.** All correlations significant, $p < .01$. Pair-wise deletion of missing cases was used; Obt. $r = \text{Obtained } r$; Cor. $r = \text{Corrected } r$; Converted Scores = BRIEF scores inverted and rescored to compare to CEFI (normative $M = 100$ and $SD = 15$); Original scores = Brief $T$-Scores (normative $M = 50$ and $SD = 10$).
## CEFI IQ and Achievement Tests

<table>
<thead>
<tr>
<th>Other Measure</th>
<th>Obtained r</th>
<th>Corrected r</th>
<th>N</th>
<th>CEFI Full Scale</th>
<th>CAS, WISC-IV, or WJ III ACH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale</td>
<td>.45**</td>
<td>.45**</td>
<td>60</td>
<td>91.4</td>
<td>91.4</td>
</tr>
<tr>
<td>Attention</td>
<td>.33*</td>
<td>.37**</td>
<td>60</td>
<td>91.4</td>
<td>91.4</td>
</tr>
<tr>
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<td>.49**</td>
<td>60</td>
<td>91.4</td>
<td>91.4</td>
</tr>
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<td>91.4</td>
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<td>CAS</td>
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<tr>
<td>Full Scale</td>
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<td>.39*</td>
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<td>WJ III ACH</td>
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**Note.** Pair-wise deletion of missing cases was used. Obt. r = Obtained r; Cor. r = Corrected r.

* p ≤ .05; ** p ≤ .01.
Can we harness executive function strategies to create educational environments capable of nurturing developing minds?
“The secret of education lies in respecting the student”
Ralph Waldo Emerson
Can strategic instructional interventions provide remedial and compensatory support for children with EF deficits?
Defining Terms
Cognitive Strategy:

- A strategy or group of strategies or procedures that the learner uses to perform academic tasks or to improve social skills.
- Often, more than one cognitive strategy is used with others, depending on the learner and his/her schema for learning.
- In fact, research indicates that successful learners use numerous strategies.
- Some of these strategies include visualization, verbalization, making associations, chunking, questioning, scanning, underlining, accessing cues, using mnemonics, sounding out words, and self-checking and monitoring.
Cues:

• Visual or verbal prompts to either remind the student what has already been learned or provide an opportunity to learn something new.

• Cues can also be employed to prompt student use of a strategy.
Independent, Strategic Learner:

• The student using cues and strategies within his/her learning schema, asks clarifying questions, listen, checks and monitors his/her work and behavior, and sets personal goals.

• A strategic learner knows the value of using particular strategies through experience, and is eager to learn others that might prove beneficial.
Learning Strategy:

- A set of steps to accomplish a particular task, such as taking a test, comprehending text, and writing a story.
- A first-letter mnemonic is often used to help the learner follow the steps of the strategy.
Metacognition and Self-Regulation:

The understanding a person has about he/she learns (personal learning schema) including the strategies used to accomplish tasks, and the process by which the learner oversees and monitors his/her use of strategies.
Mnemonic:

- A device for remembering, such as a first-letter mnemonic for writing: PLAN (Pay attention to the prompt, List main ideas, Add supporting ideas, Number your ideas) (De La Paz, Owen, Harris and Graham, 2000).

- Rhyme, rhythm, music, and key-word mnemonics are also useful memory tools.
Strategy Instruction:

Teaching students about strategies, teaching them how and when to use strategies, helping students identify personally effective strategies, and encouraging them to make strategic behaviors part of their learning schema.
Learning Schema:

- The sets, or mixes, of strategies that the individual learner uses automatically to perform, produce, communicate or learn.
- It can take years to develop a personal learning schema.
The Power of Strategy Instruction


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If you’ve ever played the game of chess, chances are you used a fairly unsophisticated approach when first making your way around the board. It’s also likely that basic tactics quickly emerged after just a few games—moves that were at first aimless and erratic became much more planned and organized. You may have played faster, you may have played better, but you likely still played a fairly unsophisticated approach compared to the professionals. If you are reading this book and have a hard time with reading and writing, you have probably never played chess. But the chess analogy should be helpful to you! That is because strategy instruction can help you become a more effective chess player—someone who moves with a plan and strategy, someone who becomes a professional chess player. With strategy instruction, you will be able to read and write more effectively, faster, better.
At School | Especially for Teachers | Effective Teaching Practices

Strategic Instruction Model: How to Teach, How to Learn

By Sheldon H. Horowitz, Ed.D.
Published: December 1, 2006

Almost 25 years ago, a group of researchers at the University of Kansas set out to change “business as usual” in terms of instruction for students with learning disabilities (LD). They recognized that adolescents were especially vulnerable to school failure, especially in the area of literacy (reading, writing, comprehension), and that these students were likely to continue to fall further behind unless they were helped to be more “strategic” in their approach to learning. Decades of classroom research and thousands of professional development hours later, we are fortunate to have an approach to teaching students (and training educators) that can help students build essential skills and learn complex subject matter as well as assist teachers imbed effective strategies into classroom instruction. And most recently, we have gained an understanding of how whole schools can adopt and support strategic approaches to teaching and learning across content areas.

Literacy First

The SIM model was developed for students who already have basic decoding and word recognition skills. That said, even students who struggle with these early reading skills need to “learn how to learn” and could benefit from classroom routines and strategies that help teachers ensure that students are learning critical content (the course material students need to meet standards) in ways that prepare them for class promotion, high school graduation, and a success after school.
Strategy Instruction

The ERIC Clearinghouse on Disabilities and Gifted Education (ERIC EC)
E-mail: webmaster@hoagiesgifted.org
Internet: http://eric.hoagiesgifted.org

ERIC EC Digest #E638
Author: Pat Beckman
December 2002

For more than two decades there has been an abundance of research regarding strategy instruction. Originally, most of this research focused on the effects of strategy instruction on students with learning disabilities. Researchers are currently looking at how strategy instruction affects all learners.

What is a strategy?

In general, a strategy is a tool, plan, or method used for accomplishing a task. Below are other terms associated with strategy instruction, some of which are discussed in this digest:

- **Cognitive Strategy**: a strategy or group of strategies or procedures that the learner uses to perform academic tasks or to improve social skills. Often, more than one cognitive strategy is used with others, depending on the learner and his/her schema for learning. In fact, research indicates that successful learners use numerous strategies. Some of these strategies include visualization, verbalization, making associations, chunking, questioning, scanning, underlining, accessing cues, using mnemonics, sounding out words, and self-checking and monitoring.
- **Cues**: visual or verbal prompts to either remind the student what has already been learned or provide an opportunity to learn something new. Cues can also be employed to prompt student use of a strategy.
- **Independent, Strategic Learner**: the student who uses cues and strategies within his/her learning schema, asks clarifying questions, listens,
What are the most essential strategies to teach?
Computation and problem-solving:

- Verbalization
- Visualization
- Chunking
- Making associations
- Use of cues
Memory:

- Visualization
- Verbalization
- Mnemonics
- Making associations
- Chunking
- Writing
- These are usually more effective when used in combinations.
Productivity:

• Verbalization
• Self-monitoring
• Visualization
• Use of cues
Reading Accuracy and Fluency:

• Finger pointing or tracking
• Sounding out unknown words
• Self-questioning for accuracy
• Chunking and using contextual clues
Reading comprehension:

- Visualization
- Questioning
- Rereading
- Predicting
• Planning, revising, questioning, use of cues, verbalization, visualization, checking and monitoring.

• How are students taught to use strategies? Effective strategy instruction is an integral part of classroom instruction, regardless of the content being taught; it is not an additional subject.

• In the transactional strategies instruction (TSI) model, strategies instruction takes place all year long with the teacher giving explanations and modeling.

• Teachers continually praise students for using strategies and use teachable moments to discuss them. Students are encouraged to help their peers become more strategic.
Steps to Strategic Teaching:

- **Describe the strategy.** Students obtain an understanding of the strategy and its purpose—why it is important, when it can be used, and how to use it.

- **Model its use.** The teacher models the strategy, explaining to the students how to perform it.

- **Provide ample assisted practice time.** The teacher monitors, provides cues, and gives feedback. Practice results in automaticity so the student doesn’t have to “think” about using the strategy.

- **Promote student self-monitoring and evaluation of personal strategy use.** Students will likely use the strategy if they see how it works for them; it will become part of their learning schema.

- **Encourage continued use and generalization of the strategy.** Students are encouraged to try the strategy in other learning situations.
Benefits of Strategy Instruction

• Students trust their minds
• Students know there is more than one right way to do things
• They acknowledge their mistakes and try to rectify them
• They evaluate their products and behavior
• Memories are enhanced
• Learning increases
• Self-esteem increases
• Students feel a sense of power
• Students become more responsible
• Work completion and accuracy improve
• Students develop and use a personal study process
• They know how to "try"
• On-task time increases: students are more "engaged"

Sam Goldstein, Ph.D.