REFLECTION SCIENCES

MEASURE WHAT MATTERS!

MEFS Average Total Score by Age

Age in Months (N)

Mean Total Score
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ABOUT REFLECTION SCIENCES

OUR MISSION

Our MISSION is to reduce gaps in achievement and opportunity by advancing the science and practice of executive function to accelerate learning.

OUR VISION

University of Minnesota scientists, experts in the executive function (EF) field, founded Reflection Sciences in 2014. The company provides tools for assessing executive function (EF) skills in early childhood and across the lifespan. EF neurocognitive skills include paying attention, utilizing working memory to reflect before acting, self-control, delaying gratification, and cognitive flexibility—all of which are involved in goal-directed problem solving. We deliver full spectrum support, offering ongoing, training, measurement, reporting and intervention tools to positively impact identified EF capabilities.

The Reflection Sciences Executive Function Model

Training ➔ Measuring ➔ Reporting ➔ Intervention

Enhanced EF Skills

Our Name Speaks Volumes

The Reflection Sciences name highlights one of the most important aspects of EF: the learned ability to reflect prior to taking action or making a decision. Knowing EF skills can be learned drove our scientists to create an effective and efficient process to measure EF skills. We know once individual EF skill levels are identified, we can train our clients to interpret results and, ultimately, to intervene to make a positive difference and change lives.
The Lifelong Impact of EF Skills

EF skills provide a foundation for growth and adaptation in a wide range of contexts. They include **working memory** (holding information in mind and updating it), **inhibitory control** (resisting impulsive behaviors), and **cognitive flexibility** (fluidly shifting from one perspective to another). Measured in childhood, EF skills are proven to predict school readiness, academic achievement, and educational attainment. They allow children to learn more quickly and easily in the classroom, and they protect children against risks associated with adversity. And EF's impact continues long after childhood. Career success, health, wealth, and well-being in adulthood are all predicted by childhood EF skills.

In addition to making a dramatic impact on human lives, the significant upside to EF is its malleability throughout the lifespan, but especially in childhood, when neural connections are rapidly forming and changing. Thankfully, measurement and prediction are not the final step. They are instead the launching pad for targeted interventions proven to boost children’s EF abilities. Once areas of need are identified, the real story begins. Interventions, aligned with continued assessment, can drive ongoing improvements that positively impact academic and socio-emotional outcomes.

The below graphic illustrates our mission to increase achievement and opportunities by enhancing EF skills early, so children are better prepared and more engaged learners.

**Our Theory of Change**
The caliber of Reflection Sciences’ academic leadership is unparalleled. Two esteemed professors in the fields of child development and neuroscience—both international leaders in their fields—developed the MEFS App™ (Minnesota Executive Function Scale) EF measurement tool and drive all organizational decisions.

**Stephanie M. Carlson, PhD**
Dr. Carlson, Co-founder and Chief Science Officer of Reflection Sciences, is a developmental psychologist and Distinguished McKnight University Professor at the Institute of Child Development, University of Minnesota. She is an internationally recognized leader in executive function measurement in preschool children and conducts research on ways to promote its healthy development in children and their caregivers. The National Institutes of Health, Institute of Education Sciences, John Templeton Foundation, and the Character Lab have supported her work. Dr. Carlson is a Fellow of the American Psychological Association and the Association for Psychological Science and serves on multiple editorial and advisory boards in the child development field.

**Philip David Zelazo, PhD**
Dr. Zelazo, Co-founder of Reflection Sciences, is a developmental neuroscientist and Lindahl Professor at the Institute of Child Development, University of Minnesota. Dr. Zelazo has catalyzed the field of developmental research on EF with new measurement tools for children. He is a world-renowned investigator of the development and neural correlates of executive function in childhood and across the lifespan. Specific topics studied include neurofeedback and the effect of mindfulness meditation on cognition and emotion. Dr. Zelazo is a Fellow of the American Psychological Association and the Association for Psychological Science. He has edited several influential volumes including the Oxford Handbook of Developmental Psychology and serves on several advisory boards.
**FLUID VISION OF INTELLIGENCE**

EF measurement revolutionizes the way intelligence has historically been viewed. IQ testing led to the perception that intelligence is set in stone. One’s IQ score was a stamp carried for a lifetime. In contrast, EF is shaped by development and intervention. Rather than quantifying intelligence as a fixed point, EF scores describe intelligence as a point moving forward through time.

“You read these alarming statistics of diagnoses with attention-deficit disorders or learning disabilities,” says Dr. Zelazo, “when it’s likely some of these kids just haven’t had the opportunity yet to develop executive function skills.”

Dr. Carlson states, “We have a real mission to reduce gaps and ensure all children’s access to opportunities. Our focus now is on interventions for those kids most at risk.”

**A Call to Action**

Our EF scale measures the ability to use one’s knowledge to achieve goals and work through challenges. EF measurement provides the best prediction of developmental outcomes available today and is the most important tool that can be employed to predict individual outcomes and chances for success in school and life. And unlike IQ, EF skills can be taught. Rather than stigmatizing individuals as do IQ scores, EF scores provide a platform and call to action.

*Because EF skills can be improved and enhanced to literally change lives,* Reflection Sciences could not be more passionate about providing training and easy-to-use tools to assess EF skills in early childhood and beyond. Our measurement tool has been tested against much more complex and time-consuming tools and obtained similar results. Additional Reflection Sciences tools help our clients address EF skill deficiencies and positively impact EF abilities.

Multiple studies demonstrate that addressing EF deficiencies can improve individual skill levels. EF skills are vitally important in today’s digitally charged academic environment. These brain-based skills control attention, thought, emotion, motivation and action. Interventions can help children grow and develop the right skills to more successfully manage EF tasks.
So, Why Isn’t Everyone Measuring EF?

Given the many benefits of EF measurement, why isn’t EF employed in virtually every relevant clinical, educational or home-based context to provide better chances for improved performance and success?

While many organizations are aware of the importance and power of EF measurement and are seeking to identify EF skill levels, available tools have not proved functional and easy to administer. For example:

- **Teacher checklist** methods designed to measure EF are time-consuming and do not effectively predict key outcomes.
- **Existing EF measures** developed for research and clinical purposes are lengthy and/or require doctoral credentials to administer.
- A **clinical psychologist** has typically performed EF testing, and the process is very expensive ($1,500 or more).
- **Other measures** are not sensitive to gradual changes across the entire preschool period. EF assessment generally has been performed for older children with identified academic performance issues and learning challenges.
- Because of this delayed measurement approach, many people associate EF testing with learning problems, without realizing its **high value for any child or person, particularly at a much earlier age.**
Under the leadership of Professors Carlson and Zelazo, science is the cornerstone of Reflection Sciences’ primary EF tool, the Minnesota Executive Function Scale (MEFS App™).

As globally recognized scholars in the executive function field, our Founders designed the MEFS App™ based on the latest developmental neuroscience. Created at the University of Minnesota and funded by the National Institutes of Health, the MEFS App™ has a long history of scientific success. The Dimensional Change Card Sort, upon which the MEFS App™ was built, has been used in hundreds of research studies around the world and contributed to most current knowledge of EF development. The tablet MEFS App™ was normed on a sample of 7,410 typically developing children ages 2-13 and 553 adults in the U.S.

With University of Minnesota and the National Institutes of Health, Reflection Sciences has developed the only EF measure that can be used with children as young as 2 and continues to achieve breakthroughs in this important field.
How MEFS App™ Can Positively Impact Children’s Lives

Kindergarten teachers report that a child’s ability to listen calmly, sit still and retain and follow rules better predicts classroom success than early literacy and math skills. Measuring EF and subsequently addressing EF deficiencies means children’s futures become brighter. Children do not necessarily set out on a predetermined path based on a dearth of opportunities to learn EF skills. Teaching EF skills can help children stay attentive, recall information, better tolerate frustration and reflect on possible consequences of their actions. Often called the air traffic controller of the mind, EF is the key to academic and life success, impacting multiple areas:

• School readiness
• Social functioning
• Academic achievement
• Mental health
• Physical health

“Kinderberry Hill has closely monitored research on Executive Function. We knew we wanted to be able to access how our children are doing in this crucial area. We were excited to learn of the ground-breaking tools being developed by Reflection Sciences and are thrilled to partner with them.”

Sara Reichstadt
Education Coordinator
Kinderberry Hill Child
Development Centers

The MEFS App™ Reach

As of recently, the tablet MEFS App™ has been...

...administered by 1,500+
Certified MEFS App Examiners...

...in 10
different languages...

...over 50,000
times...

...in 230+
unique locations spanning 36 US States and 14 countries!
MEFS App™: What the Research Says

- **Re-test Reliability.** The MEFS App™ shows excellent test re-test reliability (ICC = .93), meaning that results for a child measured twice within a short period of time (same day or after 1-2 weeks) tend to remain exactly the same, and no practice or fatigue effects are evident.

- **Convergent Validity.** Even after controlling for age, performance on the MEFS App is significantly correlated with the most commonly used research measures of EF, including the NIH Toolbox DCCS and Flanker, Head-Toes-Knees-Shoulders, delay-of-gratification “Marshmallow Test,” Luria’s peg/pencil tap, and a 60-minute EF battery developed by researchers at New York University and the University of North Carolina-Chapel Hill.

- **Easy, Rapid Administration.** The MEFS App™ is much briefer and easier to administer than other EF measurements. MEFS App™ is administered on a tablet and takes 2-7 minutes to complete (average 4 minutes, 15 seconds).

- **More Predictive of Future Performance.** The MEFS App™ is more strongly predictive of kindergarten readiness than other measures, even when controlling for age and IQ (Woodcock Johnson NU-III literacy and math subtests). The MEFS App in pre-k also predicts end-of-Kindergarten reading level, and when measured in Kindergarten it predicts first grade math achievement. We expect more long-term outcomes to be discovered with time (as the tool has been publicly available since late 2014).

- **Broad Applications.** The MEFS App™ is unique in that it is the only comprehensive EF measure that goes down to 2 years of age and extends through adulthood, under one seamless scoring system.

Reflection Sciences provides the tools to measure EF, evaluate results, and address developmental delays. In one brief, comprehensive assessment, the MEFS App™ measures:

- **Cognitive flexibility** – The ability to shift perspectives and adopt new ways of thinking.
- **Working memory** – The ability to hold information in mind and work with it to guide behaviors, as in keeping a plan in mind while acting on it.
- **Inhibitory control** – The ability to ignore distractions and suppress impulsive or inappropriate responses.
Studies show these components of EF act together to produce goal-directed behavior and, in fact, they are not separable in early childhood. One MEFS App™ score is just as reliable as a longer battery of multiple measures.

Furthermore, when children’s EF deficiencies are addressed, outcomes improve. And this improvement couldn’t be more important: EF skills allow children to make better decisions, putting them on a positive trajectory in many life domains, including school performance and peer and adult relationships. In contrast, children whose EF skill deficiencies are not addressed are at high risk for poor school performance and social-emotional issues.

Validity of the MEFS App™

Content
- Assesses working memory, inhibitory control, and cognitive flexibility in one brief measure

Convergent
- High correlations with other EF assessments, including the NIH Toolbox Battery of EF Measures and the Head-Toes-Knees-Shoulders task

Divergent
- Distinct from IQ (Stanford-Binet Early 5 correlations ~.20-.25)

Criterion Referenced
- High concurrent correlations with Woodcock-Johnson III-NU, a widely used school readiness assessment; outperforms other EF measures
- Predicts kindergarten reading level
- Predicts 1st grade math achievement

External
- Children known to have difficulty with EF perform more poorly on the MEFS App (e.g., socioeconomic disadvantage, ADHD-symptoms)

Modifications to the MEFS App™
The MEFS App™ is easily adjusted to accommodate children with physical or cognitive disabilities and has been reliably administered in a variety of settings.
SELECTED REFERENCES ON THE MEFS APP™

**Psychometric Studies:**


*MEFS App™ is sensitive to gradual age-related changes in EF:*

![Graph showing MEFS App™ Average Total Score by Age in Months in Typically Developing Children from 2-12 Years]

Note: N = 14,143; p < .0001. Bars show standard error. Ten-year-olds in this sample were mainly low-income which could explain the dip in performance.
MEFS App™ is sensitive to risk-related deficiencies in EF, over and above IQ:

![Bar chart showing highest MEFS App™ level passed for Lab, Preschool, and At-Risk groups.](chart)

MEFS App™ is correlated with early math skills:


MEFS App™ predicts first-grade math achievement:


MEFS App™ predicts end-of-kindergarten reading level:


MEFS App™ performance is lower in at-risk populations (but not at floor):


**MEFS App™ is related to brain function:**

**MEFS App™ is related to smarter decision-making:**

**MEFS App™ is related to understanding of feelings in self and others:**

**Quality of parenting is related to MEFS App Scores in parents and children:**


**MEFS App™ is responsive to EF Interventions:**

Our founders have designed the MEFS App™ for convenience and ease of administration. With the goal of reaching and positively impacting more children, the MEFS App™ is highly scalable. Important to note is how much children enjoy experiencing the MEFS App™ as a fun game. Children generally are not aware of failing or performing poorly on the MEFS App™ and instead engage with the tool in a spirit of enjoyment.

Multiple Advantages of the MEFS App™

The convenience, accuracy and potential of the MEFS App™ has no match:

- Provides a brief, reliable, valid, cost-effective, easily administered direct behavioral measure of EF starting at age 2 and extends through adulthood.
- Deployed through an engaging touchscreen tablet interface.
- Has a low entry level to allow valid measurement across a wide range of abilities.
- Delivers instantaneous results; no lengthy observations are necessary.
- Includes multiple formats for repeated administration (e.g., to measure change over time).
- Available in 10 different languages: English, Spanish, Dutch, German (Swiss), Swedish, Mandarin Chinese, Somali, Hmong, French, and Arabic.
- Includes automated scoring, adaptive to each child’s current EF level.
- Provides individual and group reports, including growth charts and graphs.
- Can be used to identify children in need of additional assessment.
- Aligned with specific tools to help you support EF skills in small group settings.
- Can be used to track the development of EF during childhood and beyond and to evaluate the effects of interventions and curricula.
Description of the MEFS App™

The MEFS App™ tablet game is administered one-on-one. Children begin at different levels appropriate for them based on their age.

At each level, children are instructed to sort virtual cards into two boxes according to specific rules (e.g., “If it’s red put it here, but if it’s blue put it here”), and switch rules with increasing difficulty across levels. (See Figure 1.) The “A” portion of the MEFS App™ asks the child to apply one rule while the “B” portion asks the child to apply a second rule.

Highly adaptive, the MEFS App™ starts at an age-dependent level and adapts to each child’s abilities. Children advance from lower to higher levels if they pass, and continue to advance until they fail. Each of the seven levels has two parts that are automatically scored. Children must be correct on at least four out of five trials to move forward. If children fail the starting level, the program automatically goes back to an easier level until the child’s current level of functioning is reached. Outcome scores are based on accuracy and response time.

MEFS App™ Tablet Requirements

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<td>▪ Android OS 5.0 or newer</td>
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We Recommend: iPad 2, iPad Pro, or iPad Air (v. 1 or 2)

Note: iPad Mini will not work (screen too small)

We Recommend: Galaxy Tab A, E, or SE, ASUS Zenpad S 8.0, or Proscan Android Tablet

Note: If you have concerns about having Wi-Fi while using the MEFS App, we recommend purchasing a portable Wi-Fi device or using a mobile Wi-Fi hotspot.
**MEFS APP™ CERTIFICATION TRAINING**

**Webinar or On-site Training**
With your subscription to the MEFS App™, it is required that all identified examiners participate in a 2-hour web-hosted training session led by one of our certified MEFS App™ Trainers. This session will provide background regarding EF, as well as instruction on how to administer the MEFS App™, view reports, and manage your data. If additional training sessions are needed or training at your own location is preferred, we can provide what you need at competitive rates.

In addition to certification training, your organization will receive ongoing administrative and technical support.

**MEFS App™ Examiner Certification Process**
Certification is essential to ensure that your data, and the group norms, are reliable and valid. MEFS App™ Examiners attend a 2-hour webinar or on-site training session hosted by a Reflection Sciences certified Trainer. The process is easy, and the Reflection Sciences team will be there to help you along the way!

A detailed Certification Training Process Checklist is available upon request.

**Test Manual to Guide Examiners**
Our Minnesota Executive Function Scale™ Test Manual contains screenshots and guidelines so certified examiners have access to step-by-step instructions. The manual provides background information regarding EF and its importance, as well as an explanation of how the MEFS App™ differs by age group.

**Train-the-Trainer Certification**
For large organizations looking to train and certify a large number of their staff, Reflection Sciences offers a Train-the-Trainer Certification Model.

**Web Portal Access**
In addition to the tablet application, the MEFS App™ has a corresponding Reflection Sciences Web Portal from which identified personnel in your organization can access and download your data. All users must be certified before they receive a login to begin conducting assessments.

“The MEFS App™ provides our early childhood teachers with baseline data regarding a child’s executive function skills, and quarterly assessments allow us to ensure our children are developing these critical skills, which are a better predictor of academic achievement.”

Wendy Webster
Director of Community Services and Communications
St. Anthony - New Brighton School District, MN
**DETAILED REPORTS**

**Individual Reports**
A sample **Individual Score Report** is included below indicating both Basal Level (the lowest level administered for which the child was able to pass both sets of rules), and Ceiling Level (the highest level administered in which the child failed). You will also have access to our National Norms to help you determine where each child falls relative to other children his/her age and which students would benefit from group or individual interventions. Assessments are automatically scored and client reports are available in real time—you also have access to all of your raw data with the click of a button.

**MEFS App™ Narrative Score Reports** help you communicate your student’s EF score to parents during parent-teacher conferences. Provides information about typical EF development and activities they can try at home to build on these foundational learning skills.

**Group Reports**
You will also be able to download reports for your group. This report will provide the statistics for your whole group, including each participant’s:

- Demographic Information
- Highest level passed, Ceiling and Basal level
- Total Score Adjusted for Response Time
- National Percentiles, Z-Scores, and Standard Scores

**We offer flexible reporting options,** meaning that if the report is missing a piece of data you would like to see, let us know and we will work with your team to build a report to fit your needs.
REFLECTION SCIENCES’ INTERVENTION GUIDE

Research has shown that children with strong EF skills, who can pay attention and reflect on what they are learning, acquire academic content more easily and are more likely than their peers to remember that content when they need it.

Understanding the importance of EF skills intervention and ongoing measurement, Reflection Sciences has created an Intervention Guide for Promotion of Reflection and Executive Function Skills: Foundations for Learning and Adaptation, appropriate for children in preschool years. The guide is a practical tool to help teachers build children’s EF capabilities through proven methodologies. Topics include:

- Assessing EF in the Classroom
- Neuroplasticity: Modifiability of the Brain
- Effective EF Interventions
- Teaching Children About EF Skills
- Practicing EF Skills in the Classroom
- Developing EF Activities
- Embedding EF into Academic Curricula
- Encouraging Children to be Mindful
- Tips for Engaging Families
- Measuring Outcomes

The guide first helps teachers grasp EF with easy-to-understand explanations and visuals; it proceeds to present sample games and intervention activities and tips for involving families in efforts to positively impact EF skills.

Sample pages available upon request.

Kiko’s Thinking Time™ Games

Kiko’s Thinking Time™ games were developed from a large body of scientific research. Each game is based on a neuropsychological task that is known to have cognitive benefits in lab studies. Kiko Labs turned these tasks into engaging games that children love to play.

The partnership between Kiko Labs and Reflection Sciences serves to provide schools and early childhood advocacy organizations with the tools to practice EF using Kiko’s Thinking Time games and concretely measure EF gains in student populations using the MEFS App™.

Visit the Kiko Labs website here: www.kikolabs.com
Clients interested in measuring EF in their early learners who need help getting started can take advantage of our Consulting Services. Our EF experts will help you to assess your organization’s needs and create a plan for assessment, intervention, and analysis.

For clients seeking additional help following the assessments, we provide data analysis and interpretation services. Our reports can be used to simply and clearly communicate outcomes to colleagues and supervisors and, ultimately, to make better data-based decisions for your organization. Our scientists also write white papers and policy reports on topics related to EF and education at the state and national level.

Now that we have shared an overview of Reflection Sciences, EF, and EF measurement, you can also consider if the Reflection Sciences’ Professional Development series meet your organization’s current needs. No matter which deployment you choose, your PD participants will come to understand that EF refers to the skills needed for the deliberate, goal-directed self-management of attention, thought, action, emotion, and motivation and will learn about targeted interventions.

Webinar Hosted:
One of our Reflection Sciences’ Professional Development Specialists can host your session via GoToMeeting (limit 25 attendees) or use your existing software through which we can capture a larger audience.

On-site Hosted:
For clients seeking a more hands-on approach to PD, we are happy to send one of our Professional Development Specialists to you! We could also consider attending your national, regional meetings, and PD days.

Licensing our Professional Development Content:
For clients interested licensing our Professional Development content, Reflection Sciences can provide you with the materials you need to deliver via webinar, face-to-face, or on your LMS platform.

Session handouts for PD Session 1: EF Skills: A Foundation for Learning and Adaptation and PD Session 2: Executive Function Skills: Interventions for Success can be found on the following pages.
## Professional Development Handout for Session 1: EF Skills: A Foundation for Learning and Adaptation

### Overview:

**Session Duration:** 2 hours  
**Intended Audience:** Early Childhood Professionals and Partners  
**What to Expect:**  
The session will combine lecture, organized discussion, and opportunities to learn firsthand about the assessment of executive function and classroom activities that build EF skills.  

**Session Description:**  
Executive function (EF) refers to the skills needed for the deliberate, goal-directed self-management of attention, thought, action, emotion, and motivation. These skills, which include cognitive flexibility, working memory, and inhibitory control, develop rapidly during early childhood, support school readiness and socioemotional competence, and more generally, serve as a foundation for effective learning and adaptation across a wide range of situations. This session will review what is known about EF and why there is currently so much interest in EF among educators, parents, mental health professionals, economists, and policy makers; how executive function is tied to the brain, and how both develop as function of experience; how to measure EF in childhood and across the lifespan; and, effective ways to support its healthy development in the early childhood classroom.

### Key ideas:

1. Understand and discuss the influence of experience on brain development and behavior.  
2. Define and discuss executive function (EF) and its development in childhood.  
3. Understand why EF is important for learning and school success.  
4. Understand how EF is measured in early childhood.  
5. Identify ways to promote the healthy development of EF.
Professional Development Handout for Session 2:
Executive Function Skills: Interventions for Success

Overview:

Session Duration: 3 hours

Intended Audience: Early Childhood Professionals and Partners

What to Expect:
The session will combine lecture, organized discussion, and opportunities to learn firsthand about the assessment of executive function and classroom activities that build EF skills.

Session Description:
This workshop on executive function intervention will draw upon existing scientific literature, illustrative videos, and interactive discussions to help participants gain a deeper understanding of executive function skills – what they are, why they’re important, and how they develop – and how to support them in young children. The material will highlight general principles for EF intervention and specific ideas for merging EF support with existing curricular and programmatic goals.

Resources:

Intervention Guidebook
Instructor will draw from the Reflection Sciences' Intervention Guide for Promotion of Reflection and Executive Function Skills: Foundations for Learning and Adaptation. The guide is a practical tool to help teachers build children’s EF capabilities through proven methodologies. The guide first helps teachers grasp EF with easy-to-understand explanations and visuals; it proceeds to present sample games and intervention activities and tips for involving families in efforts to positively impact EF skills.

Key ideas:

1. Outline and understand the background on executive function (EF).
2. Understand general take-aways from existing research on EF intervention.
3. Identify topics to reflect on and incorporate into your EF support efforts.