

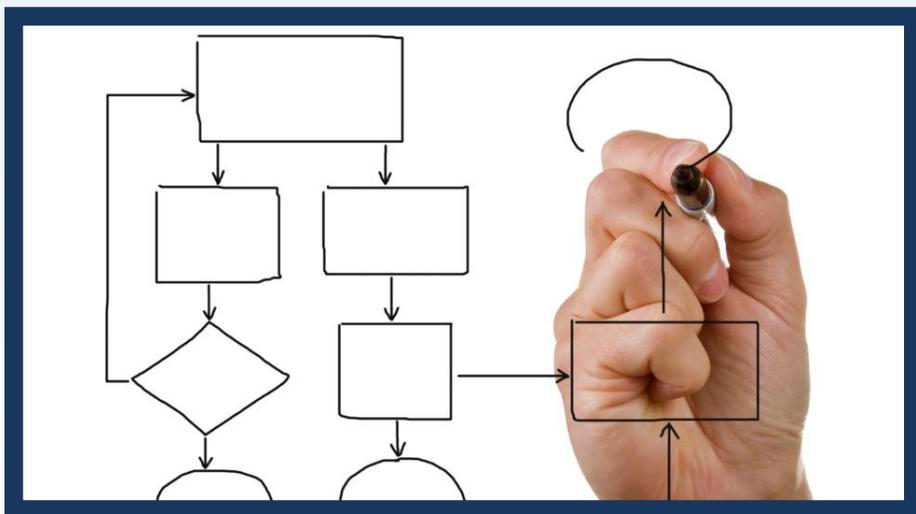
EXECUTIVE FUNCTION MAPPING PROJECT:

Untangling the Terms and Skills Related
to Executive Function and Self-Regulation
in Early Childhood

EXECUTIVE SUMMARY

OPRE Report #2016-88

October 2016



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Executive Function and Self-Regulation in Early Childhood

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Introduction

Executive function (EF) is increasingly used to refer to a variety of skills including attention, self-control, emotion regulation, creativity, and problem solving, among others. This poses a challenge for stakeholders¹ in early childhood programs and services who need to be able to identify research findings that are tied to specific skills. Current investment and interest in children’s EF presents an opportunity to equip key stakeholders with the tools to untangle and interpret the meaningful differences among EF and other regulation-related skills.

We define “EF” as the following skills: response inhibition, attention control, attention shifting (also called cognitive flexibility), and working memory.

We define “regulation-related skills” as a broader set of skills including self-control, emotion regulation, EF, problem solving, and grit, among others.

Why does this matter? Growing research suggests that EF and other regulation-related skills are particularly important for low-income children and youth.² Without a framework to clarify the differences between EF and other regulation-related skills, there is an increased likelihood of misunderstanding or mis-interpreting information about the key skills that are linked to long-term outcomes, how and when these skills develop, and the best interventions or assessments for specific skills. For example:

- **Policy-makers** run the risk of funding or promoting programs that are not efficacious for the specific needs of the populations they are trying to serve.
- **Program developers and evaluators** run the risk of misunderstanding the impact of EF-related efforts if skills are assessed using measures designed for other skills.
- **Teachers and caregivers** run the risk of choosing strategies that do not effectively target the intended skill, or are not appropriate for the intended age or context.

Audience: This Executive Summary and the accompanying Report were developed to help clarify differences between EF and other regulation-related skills for ACF leaders and staff.

Project Design

The EF Mapping Project was designed to clarify differences between EF and other skills that are sometimes inaccurately referred to as EF. The project included a literature review of approximately 160

¹ The term stakeholders refers to researchers, practitioners (including teachers, caregivers, etc.), program developers and evaluators, funders, policy-makers, individuals in the Head Start network, and others who are interested in the operationalization, measurement, and use of EF and regulation-related skills.

²Bos et al., 2009; Buckner, Mezzacappa, & Beardslee, 2003; 2009; Kishiyama et al., 2009; Shonkoff et al., 2012

recent studies about EF and other regulation-related skills, focusing primarily on preschool-aged children (3-6 years old). We found that in early childhood research, the term EF often is used synonymously with other terms, including effortful control, emotion regulation, and self-control, to name a few. In our literature review, which was designed to capture the wide array of terms and measures used in this body of research, over 40 unique terms were identified. In addition to the most commonly used terms, “executive function” and “effortful control,” the following terms emerged:

Updating	Attention Control	Effortful Attention
Working Memory - Simple	Sustained Attention	Cognitive Control
Working Memory - Complex	Impulsivity	Lack of Control
Complex EF	EC - Focusing Attention	Persistence
Inhibition	EC - Shifting Attention	Grit
Inhibitory Control	Error Detection	Self-Regulation
Response Inhibition - Simple	Monitoring	Emotion Regulation
Response Inhibition - Complex	Plan Actions (Planning)	Hot EF
Response Control	Behavioral Regulation	Cool EF
Shifting	Delay	Delay EF
Set Shifting	Suppress/Initiate	Conflict EF
Attention Shifting	Mindfulness	Executive Attention
Cognitive Flexibility	Self-Control	Executive Control
Mental Flexibility	Self-Discipline	Problem Solving
Creativity	Delay of Gratification	Goal Setting

We coded and analyzed these terms and the measures associated with them, and then developed a framework and visual “map” of skills that is intended to illustrate similarities and differences between various EF and regulation-related skills (see Map below and on pp. 12-16 of the Report; see a description of the Framework below and on pp. 17-29 of the Report). We consulted additional materials such as policy briefs, state and national learning standards, and books about early childhood development and education, to identify how authors are translating EF-related research for policy-makers, teachers, and other stakeholders. Based on this work, we generated a set of considerations and implications for research, policy, and practice – all aimed at better understanding and articulating relevant distinctions between EF and other regulation-related skills.

In this report, we primarily focused on children ages 3-6 years old because this age group is especially salient to EF-related research and interventions. In particular, the foundational EF skills begin to emerge around 3-4 years of age and increase dramatically during the preschool period.³ Additionally, most measures of EF are not suitable before 3 years of age because the assessment tasks are not developmentally appropriate, and/or the measures of EF do not capture individual differences in children before age 3. Although the focus of the report is largely the early childhood period, particularly preschool-aged children, we note that EF and other regulation-related skills are important from birth through adulthood.

³ Best & Miller, 2011; Garon et al., 2008

Below, we summarize our project findings, our proposed framework, and recommendations for the field.

Project Findings

Based on our review,

- **Finding #1 – Executive function (EF) and other regulation-related skills are important areas of children’s development and are promising targets for interventions** that aim to improve outcomes for children and families living in poverty.⁴
- **Finding #2 – Researchers and other stakeholders frequently use the term EF to describe findings that are linked to other skills, such as self-control, delay of gratification, and emotion and behavior regulation** (e.g., see Center on the Developing Child, 2011).⁵ Although EF and other regulation-related skills share common features, they differ in ways that have implications for the design and evaluation of programs. For example, the term effortful control (EC) is often used interchangeably with EF, especially during early childhood. EF and EC are similar (e.g., they both comprise multiple skills including inhibition and attention), but EF primarily involves cognitive skills such as working memory whereas EC primarily involves explicit emotion skills such as the ability to independently and appropriately manage feelings in social settings.⁶ Without transparency and precision in how stakeholders communicate about EF and regulation-related research, these differences may get lost and important areas of skill development may be overlooked.
- **Finding #3 – Rigorous research has shown that EF along with other regulation-related skills may have broad impacts on child outcomes.**⁷ Evidence frequently cited to support the claim that EF is important to target in young children comes from studies of regulation-related skills that involve multiple aspects of children’s thinking, feelings, and social behaviors. Some of these regulation-related skills are more complex than EF alone. To target these skills effectively, stakeholders could benefit from resources that articulate distinct regulation-related skills.
- **Finding #4 – Particularly in early childhood, research suggests that how children use regulation-related skills in situations involving emotions and social interactions is especially important** for children’s positive adjustment to school, as well as for diverse long-term outcomes across behavior, health, and well-being. This includes specific regulation-related skills

⁴ Bierman et al., 2008; Diamond et al., 2007; Jones, Brown, & Aber, 2011; Raver et al., 2011; Riggs et al., 2006

⁵ Center on the Developing Child at Harvard University, 2011

⁶ Zhou, Chen, & Miller, 2012

⁷ Best, Miller, & Naglieri, 2011; Blair & Razza, 2007; Bull et al., 2008; Duckworth & Seligman, 2005; Eisenberg et al., 2004; Graziano et al., 2007; Moffitt et al., 2011; McClelland et al., 2007; Raver, 2002; Valiente et al., 2011

like the ability to manage frustration, desire, and anger/aggression, and the ability to share, take turns, and comply with teacher or caregiver requests.⁸

- **Finding #5 – Important research and programmatic work is still needed to build a robust body of knowledge that can inform effective policy and practice efforts.** Our review identified a number of gaps in the literature, which suggest cautions for the interpretation of research, and point to future directions for the study of EF and other regulation-related skills. Currently, there is very little research that explores the following key questions:
 - How are EF and other regulation-related skills related to one another?
 - How is EF related to various non-cognitive or non-academic outcomes?
 - Are EF and other regulation-related skills *causally* related to academic achievement or other learning, behavior, and health outcomes?
 - Can lab-based EF tasks accurately predict skills or outcomes in real-world contexts, such as everyday classroom behavior? Similarly, do parent, teacher, and self-report questionnaires accurately predict real-world skills or outcomes?

In addition, there is a need for intervention and evaluation studies that identify what strategies are most effective for building specific EF and other regulation-related skills. Future research that explores these questions promises to help stakeholders make more informed decisions about programs and policies that support young children. To facilitate this work, stakeholders interested in EF would benefit from operationalizing EF and other regulation-related skills in clear and consistent ways.

- **Finding #6 – EF and various regulation-related skills are different from one another in four critical ways: skill complexity, developmental stage, developmental domain, and measurement strategy.** Based on our analysis of the measures used to assess different EF and regulation-related skills, we developed a framework and visual map to help stakeholders understand the similarities and differences between key EF and regulation-related skills. We introduce the framework below, on pp. 8-10.

The map (see next page) highlights key relationships between EF and other regulation-related skills, specifically according to skill complexity and developmental domain. It is intended to be illustrative and not comprehensive – it is a conceptual tool that suggests a general structure for organizing skills in EF and regulation-related research. The map is not meant to suggest a definitive developmental trajectory. However, it draws on developmental principles which suggest that smaller, simpler skills (at the bottom of the map) serve as building blocks for more complex skills (at the top). See pp. 15-16 of the full report for a more detailed description of the role of development.

⁸ Jones, Greenberg, & Crowley, 2015; Mischel, 2014; Moffitt et al., 2011; Raver, 2002

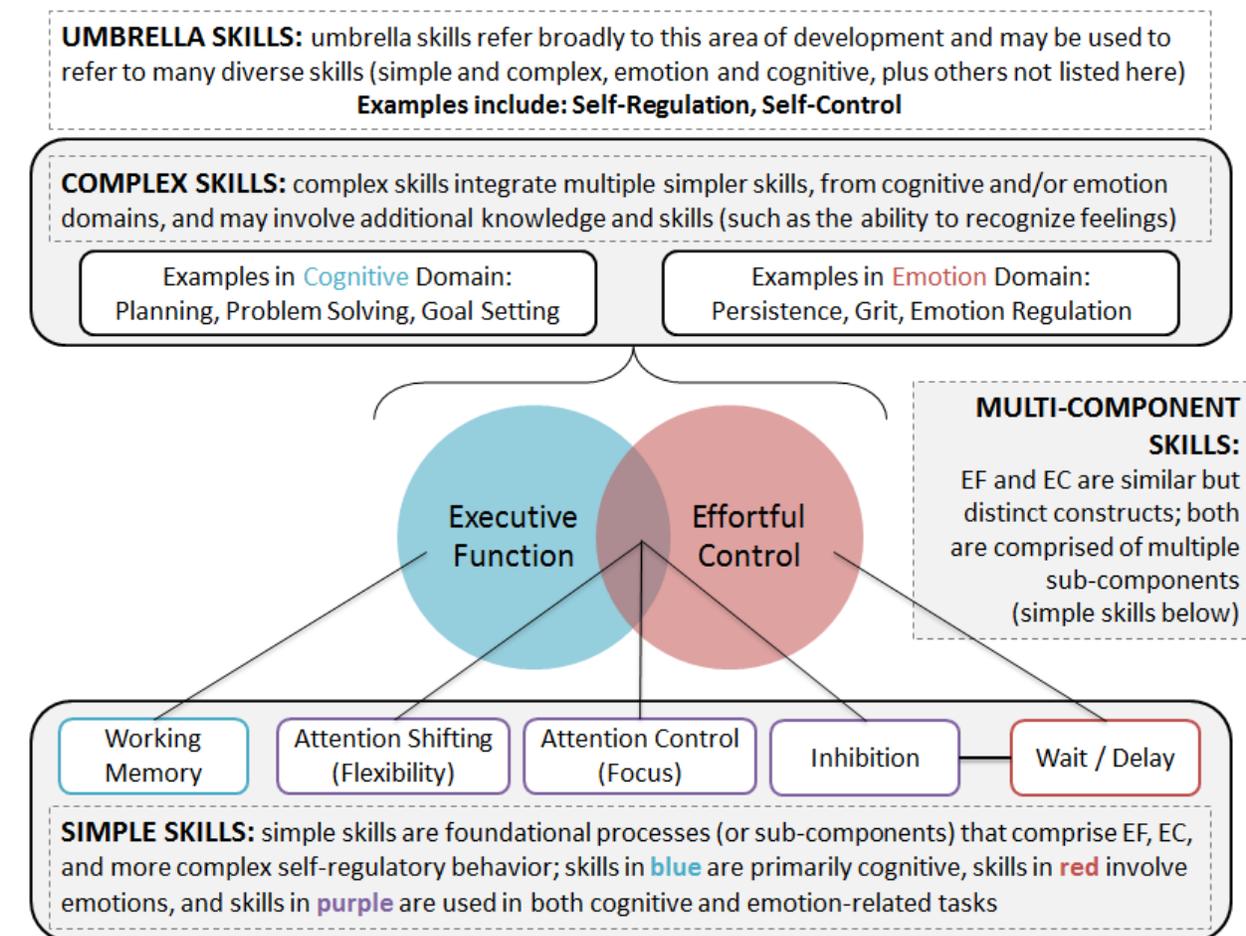
Map Legend for Skill Complexity:

- **Simple skills** are at the bottom (e.g., working memory) – these are basic processes that cannot be broken down into smaller components.
- **Multi-component skills** are in the middle (e.g., EF) – these are comprised of multiple sub-components or simpler skills.
- **Complex skills** are at the top (e.g., problem solving) – these likely involve the integration of EF with additional knowledge and skills.
- **Umbrella skills** are broader regulation-related skills (e.g., self-control) that encompass many other skills in the map.

Map Legend for Developmental Domain:

- **Skills in blue** are typically studied in cognitive research.
- **Skills in red** are typically studied in emotion-related research.
- **Skills in purple** are included in both cognitive and emotion-related research.

Exhibit 1. Map of EF and Regulation-Related Skills



NOTE: EF typically comprises the following simple skills (sub-components): working memory, attention control, attention shifting, and inhibition. Effortful control (EC) is a parallel skill, typically comprising some similar components: attention shifting, attention control/focus, inhibition, and wait/delay. These sub-components are simpler, smaller skills that work together to make up EF and EC. The map does not illustrate developmental stage or measurement strategy; see the framework section below for a description of these elements.

A Framework for Understanding EF Research, Programs, and Policies

In the accompanying Report, we describe in detail a proposed framework for untangling EF and other regulation-related skills. The framework is intended to: (a) support stakeholders to understand and articulate important differences between EF and other regulation-related skills, (b) facilitate the accurate interpretation of research findings that are tied to specific skills, and (c) support the development of evidence-based teaching strategies, assessment tools, and standards or policies that promote this key area of children’s development.

Below is a summary of the four components of the framework:

- **Skill complexity refers to the relative size or complexity of a skill.**⁹ A complex skill is large, multi-faceted, and likely involves the coordination of many simpler skills. A simple skill is typically smaller, may emerge earlier in development, and may be one of many components that together comprise more complex skills. Please note that each of the simple skills could be referred to as *an* EF, but it is more transparent to use the specific term associated with the simple skill.
 - **For Example:** working memory is a simple skill, whereas self-control is complex. Working memory is a simple skill because it is a basic process that cannot be broken down into smaller components. In contrast, self-control is a complex skill because it encompasses multiple skills, including attention, impulsivity/inhibition, EF, and emotion regulation, as well as other skills not in the map.¹⁰
 - **Take-away:** Identify the skill complexity of the skill of interest and align program activities, evaluation measures, and expectations for impact accordingly.
- **Developmental stage refers to the specific skills and findings that are most relevant for a particular age group.** Certain EF and regulation-related skills are particularly important during a specific developmental stage. For example, some skills apply to older children but do not apply

⁹ For example, playing basketball is a complex skill because it includes the coordination of many simpler skills that typically are mastered first – such as dribbling, shooting, passing, etc. Simpler skills typically serve as building blocks for more complex skills. We suggest that EF skills, such as working memory and inhibition, are building blocks for more complex regulation-related skills, such as self-control, emotion regulation, and problem solving.

¹⁰ Miyake et al., 2000; Moffitt et al., 2011

to young children. Other skills are relevant across the lifespan, but the meaning of the skill changes based on age.

- **For Example:** effortful control (EC) is relevant for young children, because individual differences in EC skills during the early childhood period are predictive of important outcomes in school and later in life.¹¹ Measures that capture individual differences in early childhood are particularly important. In addition to their use for tailoring interventions, these measures provide a stable and accurate assessment of skills, which can be challenging in this developmental stage.

In contrast, grit and self-discipline have also been linked to important school and life outcomes, but the research has focused on older children. The measures used to assess these skills are not appropriate or feasible to use in early childhood, therefore grit and self-discipline (and the findings or strategies tied to them) are relevant only for older children and adolescents.¹²

- **Take-away:** Identify the specific regulation-related skills, assessments, and teaching strategies that are most appropriate to children’s developmental stage.

- **Developmental domain refers to the domain that is most closely associated with a particular EF-related term or skill.** Certain stakeholders use the term EF to refer exclusively to mental or cognitive skills such as those measured by memory and attention tasks. At other times, stakeholders use EF to refer to skills that include aspects of emotion regulation and compliance with social norms, suggesting it fits within the social-emotional domain (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Carlson, 2005).

- **For Example:** working memory is primarily a cognitive skill, coping with frustration is primarily an emotion skill, and taking turns is primarily a social skill. Stakeholders sometimes use the term EF to refer to all of these; however, it is important to note that working memory is a sub-component of EF typically measured via cognitive tasks, coping is a regulation-related skill typically measured in the context of managing emotions, and taking turns is a regulation-related skill measured in social situations. Whereas working memory is a sub-component of EF, coping and taking turns are regulation-related skills that likely involve the use of EF.

- **Take-away:** The developmental domain of interest will likely inform the research findings and specific regulation-related skills that are most relevant.

- **Measurement strategy refers to how a skill is measured.** Sometimes EF and regulation-related skills are studied using laboratory assessments such as computer-based tasks or structured activities conducted in a research setting. Other times, EF and regulation-related skills are assessed through observations and questionnaires, including self-reports, teacher reports, or parent reports of children’s typical daily behavior.

¹¹ Lengua, 2009; Rothbart & Bates, 2006

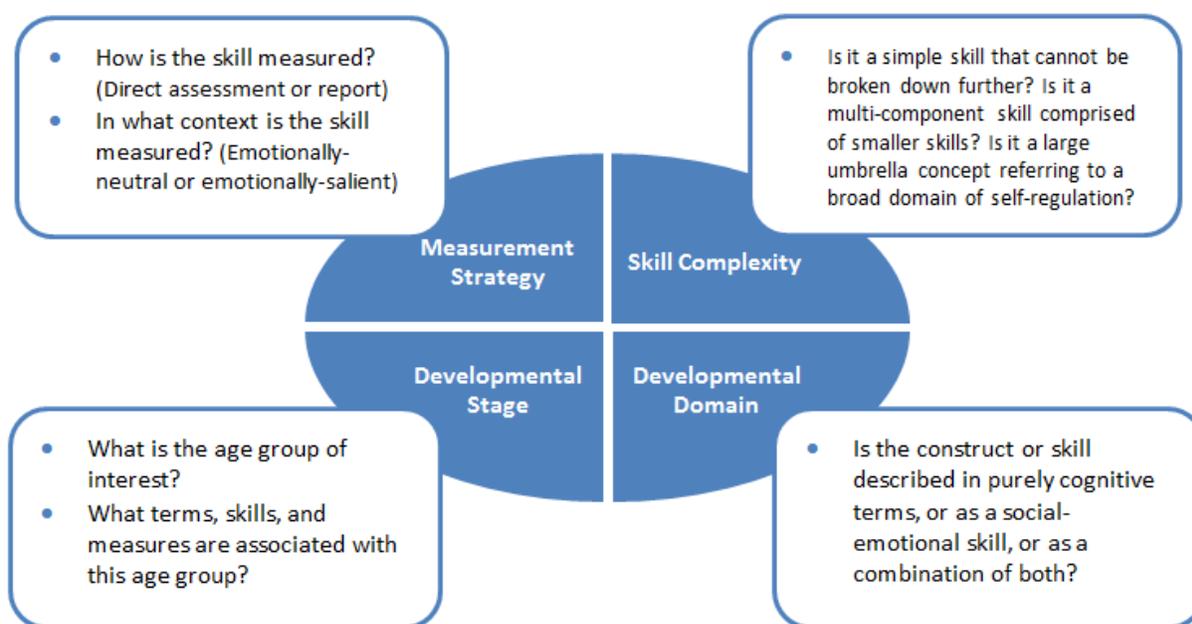
¹² Duckworth & Seligman, 2005

- **For Example:** the Continuous Performance Task (CPT) measures attention control during a computer-based task¹³, whereas the Child Behavior Questionnaire (CBQ) asks teachers how well children comply with adult requests such as maintaining attentional focus during task-related activities.¹⁴

Take-away: Identify the measurement strategy best suited for the specific EF or regulation-related skill, developmental stage, context, and outcome of interest.

We have summarized the four key issues of the framework in the figure below, including sample questions stakeholders can ask to understand and describe EF and other regulation-related skills with more clarity and precision.

Exhibit 2. Questions to consider when using the framework



Implications and Considerations for Stakeholders

Based on our review of the literature and key findings, this section lists the implications and considerations for various stakeholders. Overall, these implications and considerations reflect different stakeholders’ potential roles in communicating EF-related efforts with more accuracy and transparency.

- **For Program Developers** – Program developers and program directors benefit from defining the EF and other regulation-related skills they intend to build. When deciding what EF and other

¹³ NICHD, 2003; Rosvold et al., 1956; Sulik et al., 2010

¹⁴ Rothbart et al., 2001

regulation-related skills to target, program developers and directors should consider looking at the specific literature for the age group, developmental domain, and skill complexity of interest.

- **For Program Evaluators** – It is helpful for program evaluators to understand the specific EF and other regulation-related skills a program is trying to target in order to accurately assess its effectiveness. For example, it would be unwise to use a computerized EF task to evaluate the effects of a program designed to improve children’s regulation-related skills such as managing difficult feelings or waiting patiently in line. We suggest that program evaluators select measures that are age appropriate as well as aligned to skill complexity, developmental domain, and the program’s intended targeted skills (i.e., classroom behaviors, academic skills, social skills).
- **For Policy-Makers** – EF and regulation-related efforts often span the interests of multiple departments at the national, state, or community level, including early learning, K-12 education, health and human services, crime/safety, and workforce preparation, among others. Policy-makers may benefit from understanding what skills, approaches, or outcomes are relevant for a particular policy, such as what skills are included in state learning standards, or what regulation-related outcomes are promoted by specific human services initiatives. This allows policy-makers to facilitate alignment across different sectors that are responsible for developing, assessing, and funding various EF-related efforts.
- **For Teachers, Caregivers, and Practitioners** – Early childhood, K-12 educators, and other service providers benefit from understanding the differences between key EF and other regulation-related skills in order to identify needs and opportunities for student growth, and strategies for supporting children in specific skill areas. For example, some children may need support in attention skills, while others need practice building working memory, and others need support in learning how to manage emotions like anger or frustration. When choosing programs, activities, or strategies, it is helpful for teachers and others to have information that is specific to the skill complexity, developmental stage, and developmental domain or context of interest.
- **For Researchers** – The field would benefit from more rigorous research investigating the following:
 - Potential causal relationships between EF-related skills and various outcomes (i.e., academic, behavior, health, well-being);
 - Relationships between different skills over time (i.e., whether and how EF is related to emotion regulation or self-discipline);
 - Relationships between EF and real-world outcomes (such as daily classroom behavior);
 - The development of EF and other regulation-related skills within diverse populations (children and adults with varying demographics, such as language, ethnicity, income)

and in particular, low-income or vulnerable populations that programs and service providers are most interested in supporting; and

- Research that bridges multiple traditions (such as cognitive neuroscience, clinical psychology, and educational research). Multi-disciplinary, multi-method approaches are needed to address many of the remaining questions about how regulation-related skills impact children and youth and what can be done to effectively promote children's development in this important skill area.
- **All Stakeholders** – We suggest that all stakeholders in early childhood – researchers, practitioners, policy-makers, funders, and others – use a guiding framework to better operationalize EF-related terms in their work. In our proposed framework, we have identified four issues that can distinguish between various EF and other regulation-related skills: (a) skill complexity, (b) developmental stage, (c) developmental domain, and (d) measurement strategy. Use of the framework will promote transparency about specific skills and will allow for more accurate representations of research and programmatic findings.
- **Looking Forward** – EF and regulation-related skills need to be carefully defined and measured in future studies, findings needs to be conveyed with more transparency and precision, and researchers, practitioners, and policymakers should use specific and appropriate terms when communicating about or working in this field. We suggest the field needs additional resources, perhaps based on the proposed framework, that allows users to (1) search a specific EF-related skill, (2) locate key research tied to that skill, (3) identify assessment and teaching strategies associated with that skill, and (4) synthesize relevant findings for policy recommendations. Policy recommendations and best practices are ideally built on coherent bodies of research, but the current body of EF and regulation-related research reflects many different skills with unique findings tied to each, and is muddled by a lack of consistent or clear terminology that can articulate distinct skills. Without a guide to how different program and policy efforts operationalize the term EF, it is impossible to compare the impact of these diverse efforts. An interactive online resource would allow studies that have similar terms and measures to be compiled and synthesized with one another. Aggregating findings according to a framework would support broader policy work and provide a more accurate understanding of the science of EF.

Conclusion

The growing body of research on EF and other regulation-related skills has the potential to enhance efforts that aim to improve outcomes for children and families, especially among low-income and vulnerable populations.¹⁵ The current interest in EF research provides a context ripe for interpreting, summarizing, and categorizing findings across a broad body of research literature. With the support of

¹⁵ Bos et al., 2009; Buckner, Mezzacappa & Beardslee, 2003; 2009; Kishiyama et al., 2009; Shonkoff et al., 2012

our literature review, framework, and “map,” stakeholders would benefit from operationalizing EF and regulation-related research carefully. Our goal is to aid stakeholders in making good on their promises to improve the lives of children. In particular, careful precision and transparency in how EF and related skills are described, targeted, and measured in both research and program or policy efforts may prevent important nuances from being overlooked and areas of skill development from being neglected. In the accompanying Report, we provide more details about the project’s findings, our proposed framework, and recommendations for the field.