TeachME PROFESSIONAL DEVELOPMENT
CEU's for Teachers and Educators

Developing Grit, Tenacity, and Perseverance in the Learning Environment

Executive Summary

How can we best prepare children and adolescents to thrive in the 21st century—an era of achievement gaps that must be closed for the benefit of everyone in society, rapidly evolving technology, demanding and collaborative STEM knowledge work, changing workforce needs, and economic volatility? The test score accountability movement and conventional educational approaches tend to focus on intellectual aspects of success, such as content knowledge. However, this is not sufficient. If students are to achieve their full potential, they must have opportunities to engage and develop a much richer set of skills. There is a growing movement to explore the potential of the "noncognitive" factors—attributes, dispositions, social skills, attitudes, and intrapersonal resources, independent of intellectual ability—that high-achieving individuals draw upon to accomplish success.

In this brief, we take a close look at a core set of noncognitive factors—grit, tenacity, and perseverance. These factors are essential to an individual's capacity to strive for and succeed at long-term and higher-order goals, and to persist in the face of the array of challenges and obstacles encountered throughout schooling and life. Importantly, we are deliberate not to treat these factors as residing only within the student—it is the responsibility of the educational community to design learning environments that promote these factors so that students are prepared to meet 21st-century challenges.

What will it take to shift educational priorities to promote not only content knowledge, but also grit, tenacity, and perseverance? This is an important and exciting time to stop, take stock, and prepare to move forward. New and emerging trends in research, policy, programs, and technology are providing unprecedented opportunities. A growing corpus of research evidence suggests that these factors can be just as important as intellectual abilities for success, and new research programs are exploring ways to promote these factors. Several private foundations have recently initiated programs to push the frontiers of theory, measurement, and practice around these and related factors, particularly for at-risk and vulnerable students. In national policy, there is increasing attention on 21st-century competencies (which encompass a range of noncognitive factors, including grit), and *persistence* is now part of the Common Core State Standards for Mathematics. The popular media also reports on interest in these factors. While the United States

experiences greater economic volatility than in recent decades, broad interest in grit, tenacity, and perseverance may be rising as more adults recognize the need to better prepare the nation's young people to be resilient in the face of challenge.

This brief has a special focus on the new and emerging roles technologies can play in this paradigm shift. Technologies provide opportunities to advance education far beyond what has been possible before. Technology permits greater sophistication of assessment and adaptation to individual learning needs. It enables individuals to utilize for their own purposes an unprecedented wealth of online resources. It also provides access to worldwide interpersonal networking. These affordances provide new ways to promote agency and perseverance for individuals toward goals that have previously been more difficult to attain—particularly for those traditionally with limited access to resources.

While this domain of noncognitive factors is rich and vibrant, it is also quite nascent. Research and practice traditions in education, psychology, economics, engineering, and other fields provide a wealth of knowledge about these factors. At the same time, there are many unanswered questions, and it can be challenging to navigate this landscape of ideas. ***The purpose of this brief is to distill the critical themes, questions, conclusions, and recommendations around theory, measurement, and the design of learning environments, with an eye toward identifying potential new roles for technology.*** This brief explores the possibility that grit, tenacity, and perseverance can be malleable and teachable, and discusses the potential of these factors to significantly increase success for all students.

Research Questions and Methods

The brief addresses the following research questions:

1. What are grit, tenacity, and perseverance? What are the key components of these competencies, what psychological and contextual factors support and promote them?
2. How are these factors measured currently? How can they be measured in the future? How can technology provide new tools and strategies?
3. How can formal and informal learning environments be designed to promote these factors for a wide variety of students? How can digital learning environments be leveraged? What are illustrative case examples?
4. What are key conclusions and recommendations for practice, research, and policy?

We used two complementary research approaches to answer these questions: a systematic narrative review of the corpus of existing research and a series of interviews with 25 experts and thought leaders in the field (see Appendix). The rest of the Executive Summary discusses highlights of the answers to these questions.

What Are Grit, Tenacity, and Perseverance? A Hypothesized Model

A synthesis of findings from the literature review and interviews reveals some key principles for a hypothesized model of grit, tenacity, and perseverance (see Chapter 2 for details).

- **Grit, tenacity, and perseverance are multifaceted concepts encompassing goals, challenges, and ways of managing these.** We integrate the big ideas from several related definitions in the literature to a broad, multifaceted definition of *grit* for the purpose of this report: "Perseverance to accomplish long-term or higher-order goals in the face of challenges and setbacks, engaging the student's psychological resources, such as their academic mindsets, effortful control, and strategies and tactics."
- **Sociocultural context plays an important role.** It can be a significant determinant of what students value and want to accomplish, the types of challenges they face, and the resources they can access. It is well documented that students from high-poverty backgrounds are particularly likely to face great stress and limited social support for academic achievement—factors which can undermine perseverance toward a wide range of goals. Researchers and educators also highlight concerns about the challenges faced by students from other segments of the socioeconomic spectrum. For example, researchers and educators are exposing how grit can be *detrimental* when it is driven by a fear-based focus on testing and college entry. This can undermine conceptual learning, creativity, long-term retention, mental health, and ability to deal with "real-world" challenges.
- **Learning environments can be designed to promote grit, tenacity, and perseverance.** Our research pointed to two potentially important factors. *First, students need opportunities to take on "optimally challenging" goals that, to the student, are worthy of pursuit.* Optimally challenging goals are those that are within the student's range of proximal development—not too difficult and not too easy. Students will find goals worthy of pursuit when the goals resonate with their personal values and interests. *Second, students need a rigorous and supportive environment to accomplish these goals and/or develop critical psychological resources.* As students engage in pursuing their goals, there is a wide range of challenges they may encounter, such as conceptual complexity, distractions and boredom, lack of resources, and adverse circumstances. Students will be more likely to persevere when the learning environment has a fair and respectful climate, conveys high expectations, emphasizes effort over ability, and provides necessary tangible resources—materials, human, and time.
- **Students can develop psychological resources that promote grit, tenacity, and perseverance.** Our research pointed to three facets—all of which have been shown to be malleable and teachable in certain contexts:
  - *Academic mindsets.* These constitute how students frame themselves as learners, their learning environment, and their relationships to the learning environment. They include

beliefs, attitudes, dispositions, values, and ways of perceiving oneself. Compelling evidence suggests that mindsets can have a powerful impact on academic performance in general, and in particular on how students behave and perform in the face of challenge. A core mindset that supports perseverance is called the "growth mindset"—knowing "My ability and competence grow with my effort."

  - *Effortful control.* Students are constantly faced with tasks that are important for long-term goals but that in the short-term do not feel desirable or intrinsically motivating. Successful students marshal willpower and regulate their attention during such tasks and in the face of distractions. While this can seem austere or "no fun," research shows that students stronger in these skills are happier and better able to handle stress.
  - *Strategies and tactics.* Students are also more likely to persevere when they can draw on specific strategies and tactics to deal with challenges and setbacks. They need actionable skills for taking responsibility and initiative, and for being productive under conditions of uncertainty—for example, defining tasks, planning, monitoring, changing course of action, and dealing with specific obstacles.

- **There are potential risks and costs to grit.** It may not always be productive to persevere in the face of challenge. For example, persevering to accomplish goals that are extrinsically motivated, unimportant to the student, or in some way inappropriate for the student can potentially induce stress, anxiety, and distraction, and have detrimental impacts on a student's long-term retention, conceptual learning, or psychological well-being. Careful research is still necessary to help educators learn how to protect students and to gauge and fine-tune practices and interventions.

Measuring Grit, Tenacity, and Perseverance

To design and evaluate learning environments that promote these factors, we need valid and reliable measurement instruments that can provide quick and useful feedback. Measurement can serve many different purposes: (1) practical tools to provide feedback to educators and learners, (2) tools for program design and evaluation to yield data about whether learning goals are being met, (3) instrumentation for research into the processes involved in perseverance, and (4) diagnostic indicators about vulnerable students who need special supports. We take a close look at the types of "constructs" measurement can address, at assessment methods and their trade-offs, and at evidence-centered design (ECD) as a methodological approach for assessing complex skills (see Chapter 3 for details).

One important distinction that has implications for measurement is whether perseverance is conceptualized as a *disposition* or a *set of processes*. If conceptualized as a *disposition*,[1] measurement may target perseverance as a general or enduring tendency to persevere. Disposition measures can help researchers understand how these tendencies relate to academic variables, and they can provide helpful information to students, teachers, and parents about students' tendencies and preferences. If perseverance is conceptualized as a *set of processes*, measurement may focus on sequences of behaviors, emotions, physiological reactions, and/or thoughts that unfold over time during learning, extracting indicators of persistence and giving up. New technologies using educational data mining and "affective computing" (the study and development of systems and devices that can recognize, interpret, process, and simulate aspects of human affect) are beginning to focus on "micro-level" moment-by-moment data within digital and blended-learning environments to provide feedback to adapt learning tasks to personalized needs. Measurement may also target the *psychological resources* that contribute to and interact with perseverance: academic mindsets, effortful control, and strategies and tactics.

There are many different types of measurement methods, each with important tradeoffs.

- **Self-report** methods typically ask participants to respond to a set of questions about their perceptions, attitudes, goals, emotions, beliefs, and so on. Advantages are that they are easy to administer and can yield scores that are easy to interpret. Disadvantages are that people are not always valid assessors of their own skills, and self-reports can be intrusive for evaluating participants' in-the-moment perceptions during tasks.
- **Informant reports** are made by teachers, parents, or other observers. Advantages are that they can sidestep inherent biases of self-report and provide valuable data about learning processes. The main disadvantage is that these measures can often be highly resource-intensive—especially if they require training observers, time to complete extensive observations, and coding videos or field notes.
- **School records** can provide important indicators of perseverance over time (e.g., attendance, grades, test scores, discipline problems) across large and diverse student samples. Advantages are the capacity to identify students who are struggling to persevere and new possibilities for rich longitudinal research. Disadvantages are that these records themselves do not provide rich information about individuals' experiences and nuances within learning environments that may have contributed to the outcomes reported in records.
- **Behavioral task performance** measures within digital learning environments can capture indicators of persistence or giving up. Advantages are that new methods can be seamlessly

[1] Some people equate "dispositions" with traits that people are born with and/or cannot change. In this brief, and particularly in the context of measurement, we use the term to mean enduring tendencies, independent of any claims about their origin or malleability. The extent to which dispositions are changeable, malleable, or teachable will be highly dependent on what the disposition is and the nature of the opportunities that individuals encounter.

integrated into the learning environment and provide unprecedented opportunities for adaptivity and personalized learning. Disadvantages are that these methods are still new and require intensive resources to develop.

As the field deepens the sophistication of measurement, evidence-centered design (ECD) is an important approach that can facilitate systematic design. ECD works by providing a set of tools for specifying the constructs to be tested and the best ways to elicit evidence that students are developing the related knowledge and skills. Design tools support unpacking implicit assumptions around key questions: What skills related to grit, tenacity, and perseverance are targeted? What student behaviors and performances reveal evidence of these skills? What are the features of the tasks and situations to elicit these skills?

Programs and Models for Learning Environments to Promote Grit, Tenacity, and Perseverance

We reviewed approximately 50 programs and models for promoting grit, tenacity, and perseverance, and developed five conceptual clusters based on targeted age level, learning environment, and which facets of the hypothesized model are addressed or leveraged. While there is still a need for more empirical evidence that these factors can be taught as *transferable competencies* across situations, there are a wide range of promising programs and approaches. The five conceptual clusters are as follows (discussed in detail in Chapter 4).

1. **School readiness programs that address executive functions.** These programs at the preschool and early elementary school levels help young children develop the *effortful control* that is necessary for the transition into formal schooling. Approaches include training with games, aerobic exercise and sports, martial arts and mindfulness practices, and classroom curricula and teacher professional development. Many programs have substantial empirical evidence of their success, and a major finding is that children best develop attention regulation and self-control when they can practice skills in a supportive environment that addresses cognitive, social, and physical development together.
2. **Interventions that address mindsets, learning strategies, and resilience.** There is growing research demonstrating that brief interventions (e.g., 2 to 10 hours) can significantly impact students' *mindsets* and *learning strategies*, and, in turn, academic performance. Empirically based mindset interventions include activities that explicitly teach students to have a "growth mindset" (i.e., that intelligence grows with effort), help students frame difficulty not as personal failings but as important "bumps in the road" on the way to success, provide students opportunities to affirm their personal values to maintain clarity about why they are investing their efforts, help relate course materials to students' lives, or incorporate multiple approaches to address different needs. Empirically based learning strategies interventions

include those that help students clarify their goals and anticipate in advance how to deal with likely obstacles, develop general study skills, build a resource-rich social network, or develop content-specific metacognitive skills to monitor progress. Some programs build these types of skills as protective positive assets that support resilience in the face of adversity.

3. **Alternative school models and school-level reform approaches.** We reviewed three types of approaches. The "character education" models include explicit articulation of learning goals for targeted competencies, clear and regular assessment and feedback of student progress, intensive teacher professional development, and discourse about these competencies throughout the school culture. In the "project-based learning and design thinking" models, students develop competencies through engagement in long-term, challenging, and/or real-world problems that require planning, monitoring, feedback, and iteration. Mindsets are addressed inherently in processes of feedback and iteration, and projects are often aligned with students' interests and passions. The third type of approach is that of organizations providing support for schoolwide improvement, such as teacher professional development, networks of school communities, and strategies to improve school organizational structure. There is strong anecdotal evidence of these models' success, but further research is needed to determine impacts.
4. **Informal learning programs.** We reviewed informal learning programs that provide different kinds of support for persistence. Several provide structured social support networks for students who are the first in their families to go to college. Such programs provide academic support, community involvement, and guidance in the processes of college exploration, application, and initial college adjustment. Other types of programs focus on activities to spark and support interest and persistence in STEM professions. Many programs are beginning to teach explicitly about grit, drawing on models similar to those discussed in the character education models above. In most cases, there is strong anecdotal evidence of their success, but further research is needed to determine impacts.
5. **Digital learning environments, online resources, and tools for teachers.** We reviewed educational technologies aligned with each aspect of the hypothesized model: digital learning environments that provide optimal challenge through adaptivity; digital tools to help educators promote a rigorous and supportive classroom climate; resources, information, materials, tools, or human capital to accomplish difficult goals; motivating learning environments that trigger interest; teaching about academic mindsets; promoting learning strategies; and promoting the development of effortful control. Data is available showing impacts of many of these technologies.

Together, these findings provide a source of optimism that grit, tenacity, and perseverance can be teachable or transferable. Future work will need to examine how educators can adopt or adapt these approaches in their own settings.

Conclusions and Recommendations

We discuss specific conclusions and recommendations tailored to the needs and responsibilities of educators, administrators, policymakers, technology designers, parents, and researchers.

Conclusion 1: For significant and pervasive shifts in educational priorities to promote not only content knowledge, but also the noncognitive factors of grit, tenacity, and perseverance, there is a strong need for growing involvement and support by all educational stakeholders.

Recommendation 1: Educators, administrators, policymakers, technology designers, parents, and researchers should consider how to give priority to grit, tenacity, and perseverance in curriculum, teaching practices, teacher professional development, programs, technology adoption, and out-of-school support. They should look to the research base for best practices and programs that are mature in development and suitable to local context. Structural supports will need to be enhanced to enable educators to enact best practices and implementation of productive intervention models. Progress will also require outreach to parents and advocacy to all educational stakeholders. Research will need to continue to advance theory, measurement, and the design of technology and learning environments. The conclusions and recommendations that follow provide more specific guidance.

Conclusions and Recommendations for Practice and Implementation

Conclusion 2: Substantial research points to actionable "best practices" to promote grit, tenacity, and perseverance. Note that there is still limited evidence at scale, and the field still needs coherent methods for integrating these practices into school culture, teaching practices, curriculum, and technology—especially under conditions that present significant barriers.

Recommendation 2a: Educators and administrators interested in promoting grit, tenacity, and perseverance should draw on key *research-based best practices,* for example, (1) provide students with opportunities to take on higher-order or long-term goals that are "worthy" to the student—goals that are "optimally challenging" and aligned with the students' own interests, and (2) provide a rigorous and supportive environment for accomplishing their goals. Students should be supported in the psychological resources that will help them succeed—academic mindsets, effortful control, and strategies and tactics. Rigorous and supportive learning environments instill, for example, high expectations, a growth mindset, expectations for challenge and early failure, cycles of constructive feedback and iteration, and a sense of belonging; and support for strategies to plan, monitor, and stay on track. Supports also should include the necessary tangible resources (i.e., materials, people, time). Educators should be aware of potential risks or costs of pushing students in ways inappropriate for their needs.

Recommendation 2b: Technology developers interested in promoting grit, tenacity, and perseverance should also draw on key *research-based best practices* in establishing design principles for new technology. Technology-based learning environments should be designed by interdisciplinary teams that bring expertise, for example, in the learning sciences, software design, and domain-specific content.

Conclusion 3: Educators and researchers have demonstrated important successes in promoting grit, tenacity, and perseverance through brief interventions, teacher professional development programs, alternative school models, informal learning models, and digital learning environments. New and emerging technologies can provide opportunities for optimal challenge through adaptivity, promote academic mindsets, teach learning strategies, promote the development of effortful control, and provide motivating environments. Note that further research may be necessary to establish the effectiveness of these types of interventions at scale, how these interventions may be used with students across different ages or learning challenges, and how such interventions can best be integrated into school culture, teaching practice, and curriculum.

Recommendation 3a: Educators and administrators should consider adopting and adapting one or more of these models for their own needs and context. This should be done with caution, incorporating continuous improvement practices that include measuring and reflecting on both model implementation and key student outcomes. Successful models employ the best practices outlined in Recommendation 2 pervasively throughout the learning community.

Recommendation 3b: Educators and administrators should evaluate technology with respect to the degree to which its design is grounded in principles aligned with the research-based best practices for fostering these competencies. Educators should also be aware of the trade-offs in terms of technology requirements and flexibility in design and use by teachers.

Conclusion 4: In this accountability-driven culture, there are a wide range of systemic and structural barriers that prevent broad implementation of many best practices and programs. Limitations include short school periods with broad coverage of standards, lack of teacher training, lack of time for teachers to plan and collaborate, and lack of parental support.

Recommendation 4: Administrators, federal agencies, and foundations should provide structural supports that will enable educators to enact best practices and implementation of productive models. Administrators and educators need professional development, curriculum materials, and technological supports. Other potentially high-leverage strategies may be restructuring school days to have longer periods and increasing school staffing so that teachers can give individual students more thoughtful feedback and attention. Outreach and inclusion of

parents and other community members also can provide important bridges to promote coherence among schools and local communities.

Conclusion 5: While there is a great deal of work in this area broadly, the importance of grit, tenacity, and perseverance in education is not necessarily widely known, and stakeholders at many levels may not understand the importance of investing resources in these priorities. In many settings, awareness-raising is necessary so that teachers, administrators, parents, and all other stakeholders in the educational community see these issues as important and become invested in supporting change.

Recommendation 5a: Educators, administrators, and parents who understand the importance of these issues and are passionate about shifting educational priorities, within their own institutions and beyond, need to become proactive advocates for change in the educational community to gain buy-in, tangible support for students as they pursue big goals, financial resources, and political support.

Recommendation 5b: Researchers need to actively translate important findings to be accessible and actionable. This brief presents Anderman's (2011) 10 strategies for outreach as a path for community engagement.

Conclusion 6: Parents and guardians can also play a direct and important role in promoting their children's grit, tenacity, and perseverance. A systematic exploration of the complex roles of parents and the home environment was outside the scope of this report. However, some important themes did emerge in our interviews.

Recommendation 6a: Parents may employ some of the research-based best practices at home as they work with their children around academic goals. For example, instilling a growth mindset through consistently praising effort over ability is a simple practice that can have important payoffs. Parents can also support children in structuring their home work environments to support effortful control by minimizing distractions, and can seek out some of the intervention models, particularly informal learning programs, as resources for their children. Parents are also cautioned that there are no quick fixes around developing these capabilities—these take consistent cultivation over the course of childhood and adolescence.

Recommendation 6b: Educators implementing programs to promote grit, tenacity, and perseverance should consider outreach to parents and guardians as an important support for students as they develop new capabilities. Parents can continue and support discourse around noncognitive factors. In some contexts, parents may need to be educated about best practices.

Conclusions and Recommendations for Research

Conclusion 7: Across communities of practice and research traditions, inconsistency in conceptual terminology is a barrier to collaboration and progress.

Recommendation 7: Researchers should seek to (1) tease apart conceptual distinctions that are critical to practice and (2) construct and work within consolidated frameworks that unify concepts and findings. Collaborative partnerships, working groups, professional conferences, and peer-reviewed publications should be geared to identify and work with unifying themes and common definitions.

Conclusion 8: There is a need to develop empirically based models of pathways for developing grit, tenacity, and perseverance over time, in different contexts, and for different types of goals and challenges. Such work would inform the development of learning trajectories and selecting age-appropriate and context-appropriate interventions.

Recommendation 8: Researchers should conduct (1) longitudinal studies to develop coherent models of developmental pathways in different kinds of contexts, (2) systematic research examining the same individuals striving to accomplish goals in different contexts, and (3) systematic research about the different types of supports necessary for different kinds of goals and challenges.

Conclusion 9: It is important for students to develop grit, tenacity, and perseverance within disciplinary contexts, for example, as part of how they become proficient in mathematics, language arts, science, music, or sports. Within academic and nonacademic disciplines, there is a need to develop ways to integrate best practices for promoting these factors.

Recommendation 9: Researchers should investigate how to integrate fundamentally with discipline-specific pedagogy, curriculum, and teaching practices the supports to promote grit, tenacity, and perseverance, and key psychological resources (mindsets, learning strategies, and effortful control).

Conclusion 10: There are important opportunities to leverage new and emerging advances in technology (e.g., educational data mining, affective computing, online resources, tools for teachers) to develop unprecedented approaches for a wide range of students.

Recommendation 10: Researchers should work closely with technology developers to continue to explore how to integrate best practices into new and emerging digital learning environments that are well positioned to promote grit, tenacity, and perseverance, and key psychological resources (mindsets, learning strategies, and effortful control) for a range of purposes.

Conclusion 11: There is a critical need to advance measurement methods for several purposes: (1) practical tools for educators and learners, (2) tools for program design and evaluation, (3) instrumentation for research, and (4) diagnostic indicators to provide early warnings to schools about vulnerable students. New and emerging technologies provide important new opportunities.

Recommendation 11: Researchers should continue to investigate how to leverage and augment new technology-based digital learning environments, using methods such as educational data mining and affective computing. Research efforts should include assessment experts, who can apply techniques such as ECD to design and validate measures aligned with advances in theory.

Conclusion 12: While there are many programs demonstrating impacts in particular contexts, there is still a gap between the research and how practitioners can use the various intervention approaches effectively across a wide variety of settings for a diversity of students.

Recommendation 12: Researchers should conduct field-based implementation research at small and large scale to build on the extant research literature and leverage multidisciplinary knowledge of experts in theory, practice, and research methodology. Research methodologies should include small-scale design research grounded in the concerns of everyday practice, as well as larger-scale efficacy studies to establish variations across settings and effectiveness studies to establish impacts at scale.

Conclusion 13: Little systematic research has explored the potential *costs* or *risks* of grit under certain circumstances for academic achievement, educational attainment, and emotional well-being. For example, perseverance may be in the students' best interest when mastery-oriented goals are emphasized, but it may be detrimental under some conditions.

Recommendation 13: Researchers should investigate systematically the different reasons for demonstrating grit and potential benefits and costs in learning environments with different goal structures. Potential risks should be explored.

Conclusion 14: Researchers, practitioners, and policymakers indicated the need for a broad spectrum of multidisciplinary research on important noncognitive student competencies.

Recommendation 14: Foundations and federal agencies should invest in programmatic portfolios of research that investigate mutually informing research questions spanning the range from basic theory, to intervention and evaluation research, to assessment research. Portfolios should leverage the capacities of multidisciplinary teams and program networks.

Introduction

How can we best prepare children and adolescents to thrive in the 21st century—an era of achievement gaps that must be closed for the benefit of everyone in society, rapidly evolving technology, demanding and collaborative STEM knowledge work, changing workforce needs, and economic volatility? The test score accountability movement and conventional educational approaches tend to focus on intellectual aspects of success, such as content knowledge. However, this is not sufficient. If students are to achieve their full potential, they must have opportunities to engage and develop a much richer set of skills. There is a growing movement to explore the potential of the "noncognitive" factors—attributes, dispositions, social skills, attitudes, and intrapersonal resources, independent of intellectual ability—that high-achieving individuals draw upon to accomplish success.

In this brief, we take a close look at a core set of noncognitive factors—grit, tenacity, and perseverance. These factors are essential to an individual's capacity to strive for and succeed at long-term and higher-order goals, and to persist in the face of the array of challenges and obstacles encountered throughout schooling and life. Meta-analyses of a growing body of correlational research suggest that these factors can have just as strong an influence on academic performance and professional attainment as intellectual factors. For example, academic performance is similarly correlated to both the characteristic of conscientiousness ("dependability and will to achieve") and intellectual ability, at both the secondary and postsecondary levels of education (Poropat, 2009).

Importantly, we are deliberate not to treat these factors as residing only within the student—it is the responsibility of the educational community to explore how to design learning environments that promote these factors.

What will it take to shift educational priorities to promote not only content knowledge, but also grit, tenacity, and perseverance? This is an important and exciting time to take stock and prepare to move forward. While the United States faces many critical issues in education, new and emerging trends in research, policy, programs, and technology are providing unprecedented opportunities in this domain. At the same time, there remain unanswered questions about the extent to which grit, tenacity, and perseverance are malleable and teachable, how to measure these factors, and how to design learning environments that promote them.

The purpose of this brief is to distill the critical themes, questions, conclusions, and recommendations around theory, measurement, and the design of learning environments, with an eye toward identifying potential new roles for technology. It explores the possibility that grit, tenacity, and perseverance can be malleable and teachable, and discusses the potential of these factors to significantly increase success for all students. Theoretical foundations are grounded in reviews written primarily for research audiences, most released within the last year. This information is complemented by interviews with a broad spectrum of expert informants from practice, research, and policy domains. Investigations review and organize the empirical research and a range of approaches to measurement and intervention. The brief is also closely tied to themes in the *Expanding Evidence* report, which explores new and emerging opportunities available in an era of rapidly evolving and expanding technology (U.S. Department of Education Office of Educational Technology, 2013). It culminates in key conclusions and recommendations for practitioners, researchers, and policymakers.

For the remainder of this chapter, we provide an overview of the state of the field and lay out our research questions and methods.

A Critical Need in Education: Why Grit, Tenacity, and Perseverance?

American children in the 21st century need support as they encounter a variety of challenges unprecedented in history. As the world becomes increasingly complex, technical, multicultural, and competitive, children and adolescents also face a weakening of the family and informal community support that was once available. As discussed in more detail in the callout box below, students in high-poverty areas face particular challenges of stress, limited social support, lack of critical resources, and psychological disempowerment and disenfranchisement. These issues contribute to dramatic gaps in achievement that are detrimental to individuals and corrosive to society as a whole. It is especially important to design learning environments for these types of students that provide contextual supports to persevere through the challenges of

schooling—mastering conceptually difficult material, getting prepared for college, graduating high school, getting into and completing college, and transitioning into a viable career.

Scholars and practitioners are also exposing challenges emerging more uniquely for the middle and upper class. Education researcher Denise Clark Pope, in her 2001 book, *Doing School: How We Are Creating a Generation of Stressed-Out, Materialistic, and Miseducated Students*, provides research and vivid examples of how middle class students are being pushed so hard to get into top-tier universities that their high school years are filled with intense stress, and they are not being adequately prepared for a thriving adulthood. In our interview with Principal Dominic Randolph of the Riverdale Country School in New York City, he expressed a similar sentiment about the more privileged students coming through his private school. He had deep concern that these students knew how to work hard to "do school" but were not developing the life skills to persevere in the face of the challenges they would face in the "real world."

Challenges of Underserved Students in the United States

While all students face challenges, one of the biggest national issues for education is the achievement gap for high-poverty students. As Paul Tough discusses in his book, *How Children Succeed: Grit, Curiosity, and the Hidden Power of Character* (Tough, 2012), it is well documented that students who come from high-poverty backgrounds are particularly likely to face high stress and limited social support in the home for academic achievement—all of which can undermine perseverance toward both short-term and long-term goals in education and into adulthood. In the early years, stress and deprivation can impact the development of executive functions (i.e., self-regulation, problem-solving, and attentional control) such that students do not develop the skills necessary for the transition to elementary school. At this age, they must learn to persevere on increasingly cognitively demanding tasks and comply with norms and rules. Deficits in these skills can have a downward spiraling effect on behavior and achievement.

In adolescence, Farrell et al. (2007) investigated the problematic situations particular to urban African American middle school students whose contexts entail depletion of neighborhood infrastructure, local financial resources, and social capital, as well as rises in crime, drug use, and violence. They found that in addition to experiencing many of the same problems as other young people, these youth are likely to lack essential material support, experience victimization, and not have basic needs met. They are also likely to lack the developmental assets of supportive and functional parents, teachers, and other community adults. While left to negotiate adolescence with minimal guidance, they also face the additional challenges of being surrounded by adults coping with complex stressors.

"Stereotype threat" is a risk for students of groups with prevailing stereotypes of poor performance in school, such as ethnic minorities and girls (in math). African American students, for example, are often aware of a stereotype that African Americans do poorly in mathematics. When faced with an evaluative situation—such as a math test—students may experience what Steele and colleagues call *stereotype threat*, a threat to self-esteem that entails a felt pressure and anxiety that his or her poor performance may confirm the negative stereotype. (e.g., Steele, 1997; Steele & Aronson, 1995). This anxiety diverts attentional resources from the task at hand, undermining perseverance in the face of difficulty.

Underserved students thus face contexts that may only sparsely promote (or undermine) perseverance and provide limited opportunities to develop critical psychological resources that set them up for success. They may also lack the social resources to get academic help when needed and guidance on how to navigate the academic institution to become successful at graduating high school, getting into college, and beginning a professional career. Ethnic minority students may also be particularly prone to feelings of alienation and lack of belonging in the educational institution—both of which can undermine their desire to persevere academically.

Regardless of socioeconomic conditions, all students encounter difficult challenges and setbacks throughout their schooling. The biggest challenges that adolescents report themselves in their everyday lives are interpersonal conflicts, concerns about their changing identity, and concerns about their own future as they anticipate education, occupational, and career challenges in an increasingly competitive job market requiring higher levels of education (Seiffge-Krenke, Aunola, & Nurmi, 2009). At the day-to-day level, all students must learn conceptually complex material that takes time and attention. However, they often are bombarded with distractions from their longer-term goals, must persist through academic assignments that are important but not necessarily intrinsically interesting to them, and need to be able to manage competing demands across coursework from multiple classes and extracurricular activities. Students need to acquire skills for the 21st-century workplace that require complex knowledge work, collaboration, and changing economic conditions. Many will be preparing for STEM careers that require complicated training pathways over many years and mastery of extensive and difficult disciplinary material. And, unfortunately, many students will encounter adverse circumstances, such as bullying, illness, and family problems.

Across the board in research, practice, policy, industry, and popular culture, there is an emerging and convergent recognition that the noncognitive factors—and particularly grit, tenacity, and perseverance—must play an essential role in evolving educational priorities. This view was echoed in an April 2012 address by John Easton, Director of the Department of Education's Institute of Educational Sciences, in which he stated that a concern of national importance is to bring noncognitive factors back to the front burner in education.

An Exciting Time of Change and Progress

There is not just the realization that grit, tenacity, and perseverance are important—people from across these various disciplines and communities are making great headway in understanding what these factors are, how they operate, what it might take to incorporate them into schooling, getting the word out to the general public, and leveraging new technologies. While the evidence is still sparse that grit, tenacity, and perseverance are teachable as transferable "traits" per se across contexts, there is reason to be optimistic that learning environments can be built with contextual supports to promote these qualities and/or prepare students with internal psychological resources that can continue to pay off. For example, in just the last few years, the field has seen the following:

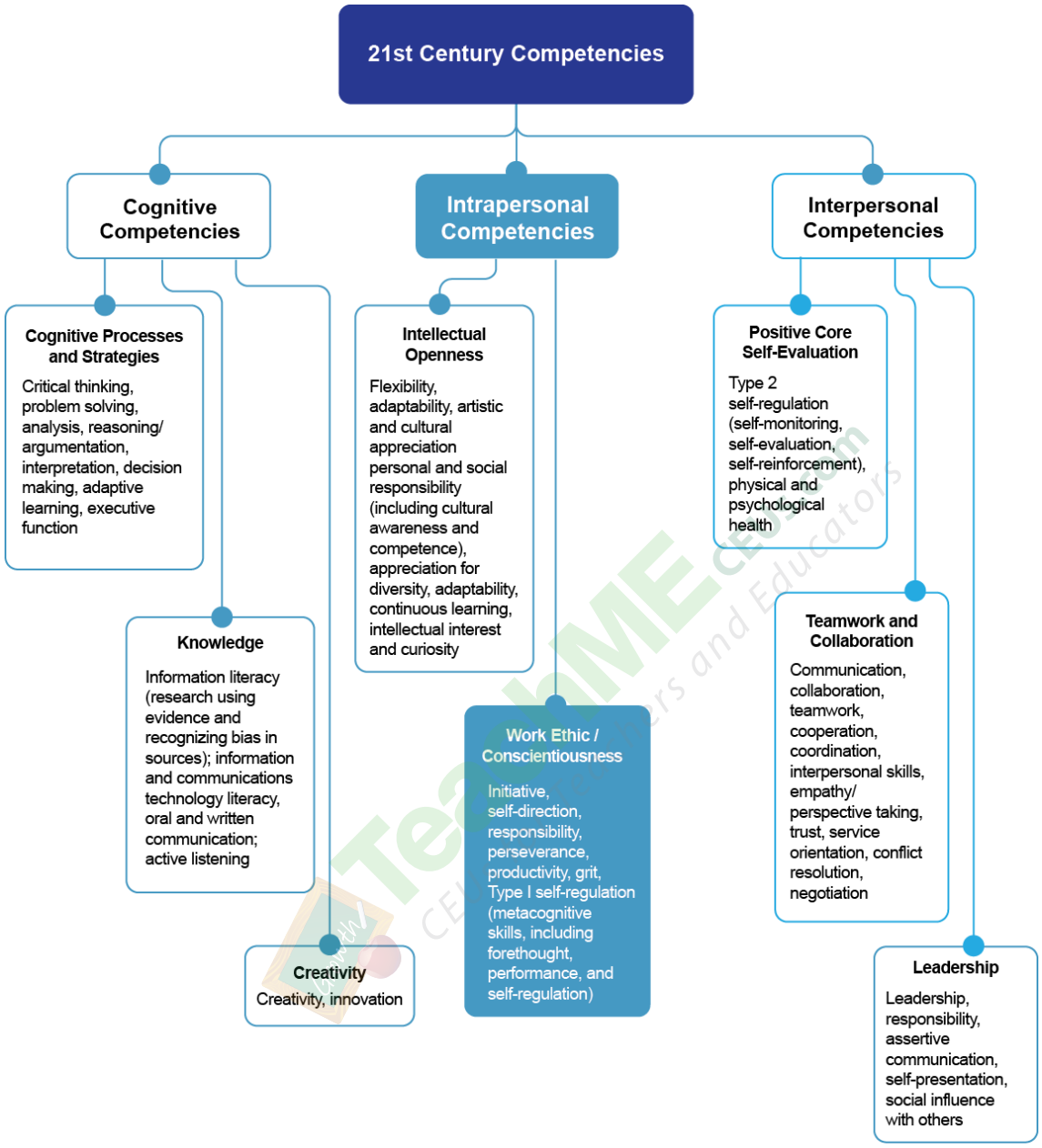
- **Research in laboratories and school settings provide a rich empirical foundation for understanding these noncognitive factors and best practices to promote them.** Building on decades of research in psychology, education, and economics, researchers are constructing theoretical models of how noncognitive factors function in education, drawing direct

implications for practices around setting up learning environments, designing curriculum, and providing teacher professional development.

- **A broad range of programs across settings have begun to implement and test models to teach and/or promote these factors for a wide variety students across age levels.** In our interviews and literature review to prepare this brief, we encountered many programs and approaches already under development or in progress to teach and/or promote a range of aspects of grit, tenacity, or perseverance for students across the age span from preschool to postsecondary education. Settings include school readiness programs, brief interventions in schools, alternative school models and school-level reform approaches, informal learning programs, and digital learning environments, online resources, and tools for teachers. Many of these programs have data suggesting impacts on both perseverance and achievement.
- **Private foundations have initiated programs intended to push the frontiers of theory, measurement, and practice around these factors.** In the last couple of years, for example, The Bill & Melinda Gates Foundation, the Raikes Foundation, the Lumina Foundation, the Stupski Foundation, the Spencer Foundation, the Moore Foundation, and the MacArthur Foundation have all initiated programs that have made significant advances in the field. Some examples follow:
  - Foundations funded comprehensive research literature reviews on academic tenacity (Dweck, Walton, & Cohen, 2011), the role of noncognitive factors in shaping school performance (Farrington et al., 2012), and the landscape of student academic mindset interventions (Snipes, Fancsali, & Stoker, 2012).
  - The Gates Foundation, in the Engagement Pedometer initiative, has engaged a network of experts in measurement to create a new generation of measurement approaches building on new technologies (Dieterle & Vasudeva, 2012).
  - The Raikes Foundation, in the Middle Shift initiative, has been working with a network of researchers and practitioners to increase the capacity to foster "agency"—persistent behavior in alignment with the mindsets and learning strategies necessary for success in college, career, and life—for the nation's at-risk 10- to14-year-olds. They are leveraging the work of several organizations that have already begun building and implementing models in formal and informal school settings.
  - The Moore Foundation sponsors the Science Activation Lab, which is conducting research to understand the most important contributing factors for persistence in participation in science and how to leverage these in the design of learning environments.
  - The MacArthur Foundation's Digital Media & Learning Program is investigating how to leverage new digital and social media to provide students with material resources and human capital that make it possible to achieve goals that have previously been unattainable by many students.

- **These factors have come into the spotlight in important national educational policy documents and initiatives.** Some examples follow:
  - In summer 2012, the National Research Council released a report entitled *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21-st Century* (NRC, 2012). In this report, the Committee on Defining Deeper Learning and 21st-Century Skills laid out a research-based framework of the critical competencies and recommendations for research, policy, and practice. As shown in Exhibit 1, it points to three broad domains of competence: cognitive, intrapersonal, and interpersonal. Grit, tenacity, and perseverance are in the center of the intrapersonal domain, which involves "the capacity to manage one's behavior and emotions to achieve one's goals" (p. Sum-3). They present a series of recommendations for how to move this work forward in research, policy, and practice.
  - Authors of the Common Core State Standards for Mathematics have acknowledged the fundamental need for perseverance in conceptual learning. They have incorporated it explicitly in the practice standard: "Make sense of problems and persevere in solving them." This standard encompasses that students "monitor and evaluate their progress and change course if necessary." The standard is consistent with findings in the math education research literature that one of the most important features of teaching that consistently facilitates students' conceptual understanding is "students struggle with important mathematics" (Hiebert & Grouws, 2009, p. 387).
- **These factors have taken the stage in the popular media, indicating their appeal to the general public.** As an indication of the appeal of and demand for these factors in the general public, we turn to the popular media, where there has been increasing attention on their importance. In September 2012, Paul Tough's book, *How Children Succeed: Grit, Curiosity, and the Hidden Power of Character*, was released and received wide national attention. According to the book's overview, it "introduces us to a new generation of researchers and educators who, for the first time, are using the tools of science to peel back the mysteries of character…he uncovers the surprising ways in which parents do—and do not—prepare their children for adulthood. And he provides us with new insights into how to improve the lives of children growing up in poverty" (Tough, book sleeve). There have also been recent articles, newscasts, and blogs on the subject of these noncognitive factors in *Time Magazine*, *The New York Times Magazine*, *National Public Radio*, *Mind/Shift*, and the *Marshall Memo*.

Exhibit 1. Clusters of 21st-century competencies



Source: Adapted from National Research Council. (2012). *Education for life and work: developing transferable knowledge and skills in the 21st century.* Washington, DC: The National Academies Press.

- **New technologies are providing opportunities with the potential to advance education far beyond what has been possible before.** As discussed in the *Expanding Evidence* report (U. S. Department of Education Office of Educational Technology, 2013), the landscape of educational technology is rapidly expanding and evolving. Across formal and informal learning settings, blended learning situations are increasingly integrating classroom-based

activities with technologies such as web-based digital learning resources, intelligent tutoring systems, online courses and learning communities, feedback systems such as "clickers," games that engage players as they learn content, and simulations of complex real-world phenomena. These technologies are increasing in ubiquity as they become not only more usable, affordable, and adaptable, but also more accessible through open digital repositories and resource sharing platforms. They provide a variety of new affordances that can be leveraged to support students' grit, tenacity, and perseverance in several ways. Key examples follow:

- Technology permits greater sophistication of assessment and adaptation to individual learning needs. New forms of data structures can capture learning events at a "micro-level," such as time-stamped, categorized, and/or automatically scored data for each significant interaction the student has with a learning system. Such data can be used in a variety of ways to allow for adaptation. It can be used within a system to provide instruction to match student needs and interests, it can generate customized feedback to learners, it can detect when students are bored or frustrated and responsively change the activity to reengage them, and it can be provided to instructors to help them make instructional decisions.
- Technologies that integrate different documents, textbook and multimedia materials, devices, and sources of information are providing supports to help students stay organized, manage time, and feel confident.
- Technology enables students and teachers to utilize for their own purposes an unprecedented wealth of online and digital resources. Online communities, repositories of educational materials and technologies, online courses, and digital media creation tools are reshaping how educational institutions function, providing widespread information, tools, mentoring, and peer support that have previously been unavailable. These affordances provide new ways to promote agency and perseverance for individuals toward goals that have previously been unattainable—particularly those traditionally with limited access to resources.

An Important Time to Take Stock and Prepare to Move Forward

While the work to date is rich, exciting, and full of possibilities and opportunities, a common theme in the literature and across all of our interviews with researchers, practitioners, and policymakers, is that there is still much that needs be done for grit, tenacity, and perseverance to become a pervasive priority in education. ***There are no quick fixes***—making significant progress requires the efforts of all communities of educational stakeholders and fundamental paradigm shifts in the culture of education.

We must also consider that this is a rich, but nascent field. In fact, the term "grit" made it into the research literature as a viable topic of study in education only as recently as 2007 (i.e., Duckworth, Peterson, Matthews, & Kelly, 2007). The NRC report on 21st-century skills points out that there has been extensive research and advances in understanding around cognitive competencies, but the research on the intrapersonal and interpersonal competencies is limited, and primarily correlational in nature. This limitation is consistent with the historical emphasis on intellectual factors over noncognitive factors in research, practice, and policy. Core recommendations of the NRC report are that foundations and federal agencies should support research programs to develop theory, assessment, and interventions that fill critical gaps (NRC, 2012).

With the wealth of progress and information distributed broadly across communities, it is an important time to step back, take stock, and prepare to move forward. There is a strong need to look across the variety of areas of work to distill the major themes; evaluate the state of the field's empirical understandings; find out what is actionable in terms of best practices, technology, measurement, and the design of learning environments; and uncover important gaps in practice, research, and policy. To construct this report, the methods were designed to allow us to examine the rich theory and evidence that *does* exist, and draw out specific conclusions that we *are* and *are not* in a position to make at this point, along with recommendations for moving forward.

Research Questions and Research Design

This brief was designed to integrate answers to driving research questions into a useful framework with accompanying conclusions and recommendations. The remaining chapters will focus on the following questions:

1. What are grit, tenacity, and perseverance? What are the key components of these competencies, what psychological and contextual factors support and promote them?
2. How are these factors measured currently? How can they be measured in the future? How can technology provide new tools and strategies?
3. How can formal and informal learning environments be designed to promote these factors for a wide variety of students? How can digital learning environments be leveraged? What are illustrative case examples?
4. What are key conclusions and recommendations for practice, research, and policy?

We used two complementary research approaches. The first was a systematic exploration of the corpus of existing research and narrative review. Following research synthesis methods (e.g., Cooper, 1989; Cook et al., 1994; Lipsey & Wilson, 2001), we began with a systematic search for

research reviews and individual studies. Using literature search databases and talking to experts in the field (see interviews below), we sought out key literature reviews that examine educational outcomes and facilitating factors for grit and other noncognitive characteristics, such as engagement, academic tenacity, and intrapersonal 21st-century skills. We also conducted ancestry searches (i.e., mining bibliographies), a manual search of the tables of contents of major educational research journals over the past 10 years, and manual search of websites of key experts and organizations. We then screened each for relevance and quality, and examined overall findings, methodological assumptions, theoretical conclusions, and inferences that could be drawn. We extracted important and relevant themes for answering our research questions.

The second approach was to interview experts and thought leaders in the field to gather their perspectives on the issues raised in the questions. We identified high-profile and respected researchers, practitioners, policymakers, and funders who are experts or thought leaders in noncognitive factors in education. In part, this roster was drawn from the authorship of key pieces of literature. Other interviewees were nominated in consultation with Department of Education or other informants, using a "snowball" process, to identify the best possible informants. The semistructured interview protocol developed for each informant was designed to elicit in-depth responses around key emerging issues, adding to, refining, confirming, or disconfirming conceptual elements in our literature review and leading to the development of the overarching framework. We also used these interviews to identify use cases that would be helpful in highlighting key concepts. Interviews were conducted by phone, except in a few cases when in-person interviews were particularly useful or convenient. Extensive notes were taken on responses during interviews; in some cases, the interviews were recorded and transcribed. Analysts summarized the interview data for each informant and coded it thematically with respect to the research questions.

We synthesized the findings from these two approaches to create the integrated framework, explicating theoretical assumptions and putting forth what we consider to be the most useful conceptualizations and recommendations. The Reference section indicates the key literature reviews that were used, and informants are listed in the Appendix.

What Are Grit, Tenacity, and Perseverance? A Hypothesized Model

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As the field seeks to understand how to promote grit, tenacity, and perseverance, there is a need for common language and shared understandings. Research on these concepts has roots in many different traditions and communities, and the concepts are complex and multifaceted. Further, different communities address them in different ways, emphasizing different pieces of the puzzle. This can make it difficult to navigate the terrain and develop shared understandings.

In this chapter, we review the research literature and organize the concepts into a hypothesized model. We begin by discussing definitions of the family of concepts, pulling out the common themes. We then present our model and explore highlights of the literature around each key facet. We emphasize that this is a *hypothesized* model; the research literature does not yet lend itself to a rigorously tested comprehensive theory. We use this as a framework in Chapters 3, 4, and 5 to structure our explorations of measurement, interventions, and conclusions and recommendations. The chapter concludes with an exploration of the "dark side" of grit—the potential risks and costs of too much or poorly motivated grit.

Definitions of Terms

School engagement researchers Reschly and Christenson (2012) describe a phenomenon in the field called the "Jingle/Jangle" Problem—"jingle" occurs when the same term is used to refer to different concepts, and "jangle" occurs when different terms are used for the same concept. Indeed, a common finding across our interviews and in the literature was different ideas about what exactly grit, tenacity, and perseverance are and that there is a need to clarify both the terminology and conceptualizations. In this section, we review a family of related terms and definitions, concluding with one we developed to use throughout this report.

Exhibit 2 presents key terms and definitions from prominent scholars. A common theme among most of them is the exertion of effort or will necessary to achieve goals (the notable exception, discussed below, is *resilience*). The definitions around *grit*, *academic tenacity*, *agency, academic perseverance*, and *persistence* also include a tendency to keep going in the face of failure, adversity, obstacles, and setbacks. There are also important differences among these. Duckworth and colleagues describe *grit* in terms of persistence over *years* to attain difficult long-term goals. They characterize this with respect to stamina, emphasizing the role of effort, interest, and passion in staying on course over the long haul.

But persistence in the face of challenge can also be important at shorter timescales and may have a variety of different contributing factors beyond interest and passion. Dweck and colleagues (2011) discuss *academic tenacity* in terms of the *mindsets and skills* that allow students to set short-term concerns aside to withstand challenges and setbacks en route to longer-term or higher-order goals. By *mindsets*, these authors are referring to how students frame themselves as learners, their learning environment, and their relationships to the learning environment. These include beliefs, attitudes, dispositions, values, and ways of perceiving oneself. *Skills* refer to strategies, such as planning, monitoring, and modifying actions. The Raikes Foundation (2012) uses a similar definition for *agency.* Farrington and colleagues include grit and persistence in their superordinate definition of *academic perseverance*, and incorporate the additional notion of effortful control—delayed gratification, self-discipline, and self-control. Note that these authors do incorporate mindsets and skills into their overall model of noncognitive factors in academic success, but separate these out from academic perseverance. The NRC (2012) uses *conscientiousness* as a broader term that contains *grit*, and also includes mindsets and skills of a sort, folding in the additional aspects of initiative and productivity.

The school engagement literature has close ties as well, as this research tradition emerged in part to explore how to prevent school drop-out and support persistence to graduation. Fredricks and colleagues' (2004) definition of *behavioral engagement* includes the participation necessary for achieving academic goals and *cognitive engagement* encompasses the effort necessary to master complex skills.

Resilience is another closely-related term, representing an extensive research tradition with important overlap with grit, tenacity, and perseverance. Research and intervention work around resilience focuses on how individuals "bounce back" from adverse and traumatic life experiences. It inquires into which social and emotional assets within the person and their environmental context are most protective in the face of risk, supporting positive outcomes. A departure from grit, tenacity, and perseverance is that resilience does not focus on the attainment of goals specifically; rather, it is indicated by positive adaptation in the face of risk. However, as Masten, Cutuli, Herbers, & Reed (2009) point out, positive adaptation for children and adolescents may include attainment of achievements that are consistent with expected developmental milestones. While we have chosen not to include resilience specifically in our model, we draw on the resilience literature to gain insight into the special case of persevering toward goals in the face of adverse life events.

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Exhibit 2. Contrasting definitions of key terms

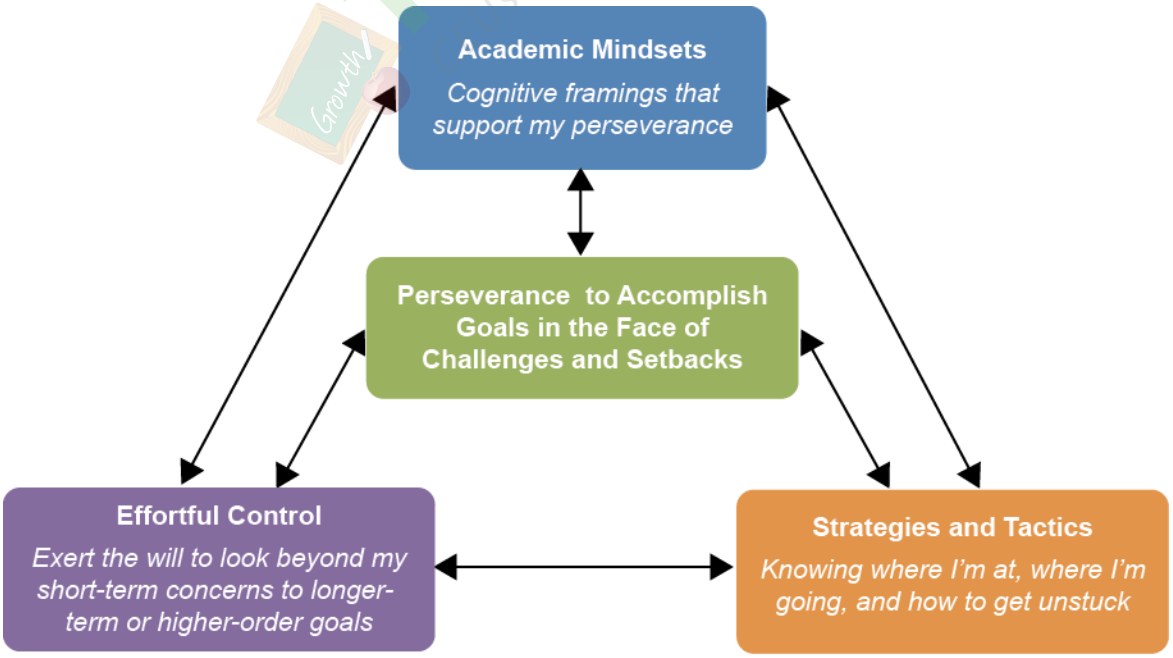
Term and Reference	Definition
Grit (Duckworth et al., 2007, pp. 1087-1088)	Grit entails working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress. The gritty individual approaches achievement as a marathon; his or her advantage is stamina. Whereas disappointment or boredom signals to others that it is time to change trajectory and cut losses, the gritty individual stays the course.
Academic Tenacity (Dweck et al., 2011, p. 5)	Academic tenacity is about the mindsets and skills that allow students: • To look beyond short-term concerns to longer-term or higher-order goals, and • To withstand challenges and setbacks to persevere toward these goals.
Agency (The Raikes Foundation, 2012)	By building agency, young people utilize effective learning strategies and demonstrate a positive mindset that not only helps them drive their own learning to do better in school, but also helps them to navigate the typical barriers to success, both inside and outside the classroom.
Academic Perseverance (Farrington et al., 2012, p. 9)	Academic perseverance refers to a student's tendency to complete school assignments in a timely and thorough manner, to the best of one's ability, despite distractions, obstacles, or level of challenge…To persevere academically requires that students stay focused on a goal despite obstacles (grit or persistence) and forego distractions or temptations to prioritize higher pursuits over lower pleasures (delayed gratification, self-discipline, self-control).
Persistence and Perseverance (Peterson & Seligman, 2004, p. 229-230)	We define persistence as voluntary continuation of a goal-directed action in spite of obstacles, difficulties, or discouragement. Simply measuring how long someone works at a task does not adequately capture the essence of perseverance because continuing to perform something that is fun or rewarding does not require one to endure and overcome setbacks. We use the terms *perseverance* and *persistence* interchangeably.
Conscientiousness as a 21st Century Competency (NRC, 2012, pp. 2-13)	Initiative, self-direction, responsibility, perseverance, productivity, grit, Type I self-regulation (metacognitive skills, including forethought, performance, and self-reflection).
Conscientiousness as a Personality Factor (Poropat, 2009, p. 322)	Dependability and will to achieve.
Engagement (Fredricks et al., 2004, p. 60)	The multifaceted nature of engagement is also reflected in the research literature, which defines engagement in three ways. *Behavioral engagement* draws on the idea of participation; it includes involvement in academic and social or extracurricular activities and is considered crucial for achieving positive academic outcomes and preventing dropping out. *Emotional engagement* encompasses positive and negative reactions to teachers, classmates, academics, and school and is presumed to create ties to an institution and influence willingness to do the work. Finally, *cognitive engagement* draws on the idea of investment; it incorporates thoughtfulness and willingness to exert the effort necessary to comprehend complex ideas and master difficult skills.
Resilience (Masten et al., 2009, p. 117)	Positive adaptation in the context of significant challenges, variously referring to the capacity for, process of, or outcomes of successful life-course development during or following exposure to potentially life-altering experiences

For the purpose of this report, we have decided to integrate key ideas from these definitions into a broad, multifaceted definition of grit. As illustrated in Exhibit 3, the big ideas we have drawn out are (1) perseverance to accomplish goals in the face of challenges and setbacks, and (2) engaging the mutually influencing *psychological resources*:

1. *Academic mindsets.* These are how students frame themselves as learners, their learning environment, and their relationships to the learning environment. Mindsets include beliefs, attitudes, dispositions, values, and ways of perceiving oneself.
2. *Effortful control.* Students are constantly faced with tasks that are important for long-term goals but that in the short-term may not feel desirable or intrinsically motivating. Successful students marshal willpower and regulate their attention in the face of distractions.
3. *Strategies and tactics.* Students are also more likely to persevere when they can draw on specific strategies and tactics to deal with challenges and setbacks. They need actionable skills for taking responsibility and initiative, and for being productive under conditions of uncertainty—for example, defining tasks, planning, monitoring, and dealing with specific obstacles.

Exhibit 3. A broad definition of *grit* for the purpose of this report

Perseverance to accomplish long-term or higher-order goals in the face of challenges and setbacks, engaging the student's psychological resources, such as their academic mindsets, effortful control, and strategies and tactics.



A Hypothesized Model

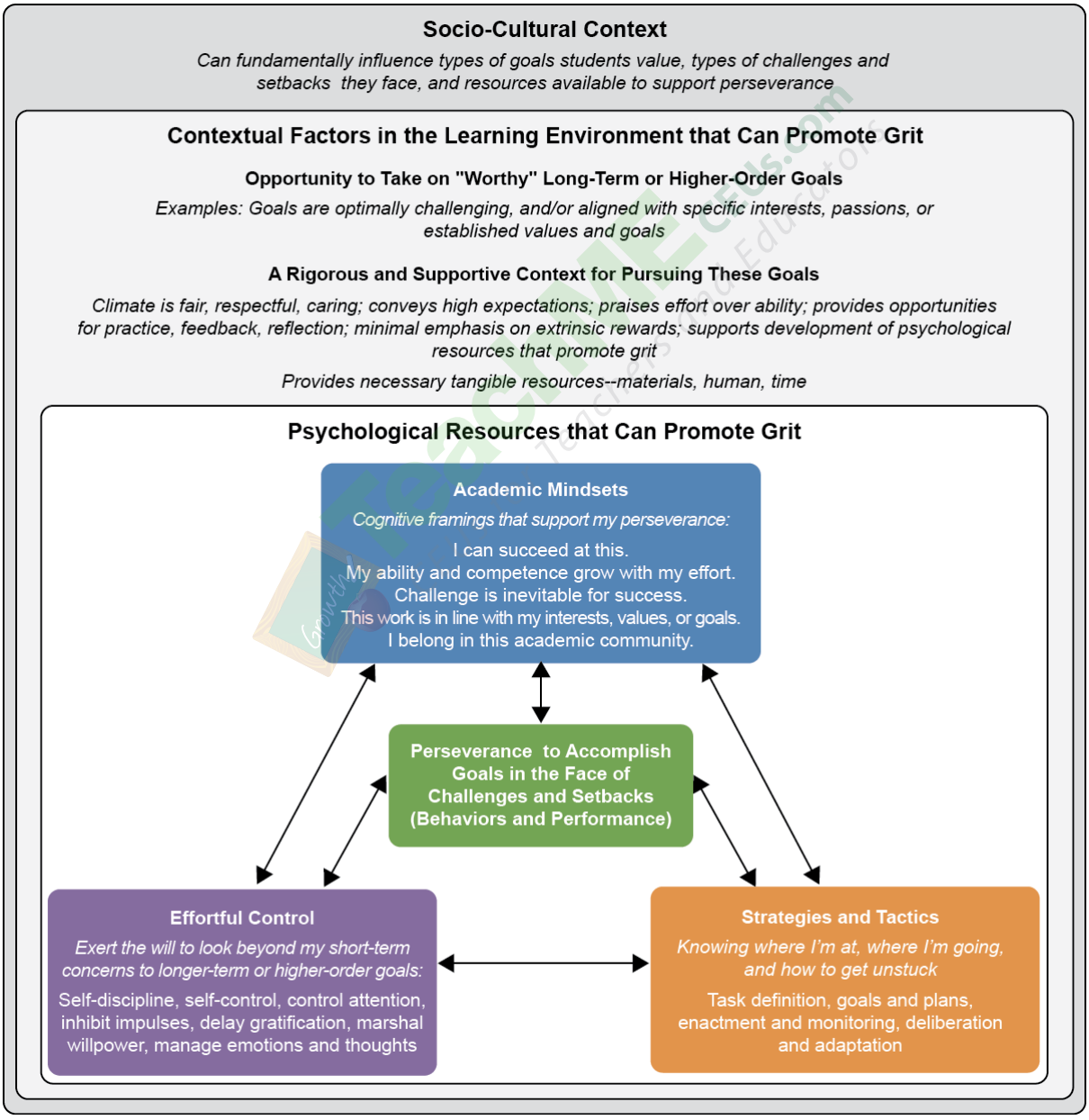
This hypothesized model integrates findings from our interviews and six research reviews (or sets of reviews):

1. The 2012 report released by the University of Chicago Consortium on Chicago School Research presented a comprehensive review of the research literature on the role of noncognitive factors in shaping school performance (see Farrington et al., 2012). This report articulated a hypothesized model of noncognitive factors broadly and examined the research on how major categories of noncognitive factors—academic mindsets, academic perseverance, learning strategies, and social skills—influence academic behaviors and performance. We focus on the categories particularly relevant to the support and development of grit, tenacity, and perseverance.
2. The National Research Council's 2012 report, *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century* (NRC, 2012), includes a detailed literature review of the noncognitive factors.
3. Research reviews by Dweck and colleagues (2011), Yeager and Walton (2011), and Snipes and colleagues (2012) provide comprehensive overviews of the research on mindsets and interventions that are being tested to impact them.
4. Research and reviews by Duckworth and colleagues explore the various facets of effortful control across multiple populations and developmental stages (Duckworth & Allred, 2012; Duckworth & Kern, 2011; Duckworth, Peterson, Matthews, & Kelly, 2007; Duckworth, 2009, 2011). An additional review by Diamond and Lee (2011) lays out approaches for improving executive functions in the early school years.
5. The 2003 report *Engaging Schools*, released by the National Research Council and Institute of Medicine, provides a comprehensive review of the literature on fostering students' motivation to learn (see National Research Council and Institute of Medicine, 2003). These factors are also directly applicable to promoting grit and persistence.

Exhibit 4 presents the full model. In the following sections, we examine the research around each facet. At the end of the chapter, we will return to the model as a whole, discussing hypotheses about the relationships among each of the facets and contextual factors.

Exhibit 4. Hypothesized model of grit, tenacity, and perseverance, and the contextual factors and psychological resources that promote them

Students pursue a wide range of goals and encounter many different types of challenges and setbacks. Socio-cultural context can play an important role in determining what students value and want to accomplish, the types of challenges they face, and the resources to which they have access. Their perseverance may be directly influenced by contextual factors in the learning environment and can require engagement of important psychological resources—academic mindsets, effortful control, and strategies and tactics.



Socio-Cultural Context

Socio-cultural context can play a fundamental role in influencing the types of goals students will value, the types of challenges and setbacks they will face, and the resources they will have access to for supporting perseverance. As discussed in Chapter 1, underserved student populations face particular challenges of stress, limited social support, lack of critical resources, and psychological disempowerment and disenfranchisement. These issues contribute to dramatic gaps in achievement that are detrimental to individuals and corrosive to society as a whole. Scholars and practitioners are also exposing concerns that children in the middle and upper classes are learning how to work hard to "do school" but are not developing the life skills to persevere in the face of the challenges they will face in the "real world." A critical question in education is how to set up learning environments for a wide variety of students that are most likely to promote grit, tenacity, and perseverance. In Chapter 4, we will explore a range of interventions that are being developed and showing success for different types of populations.

Contextual Factors in the Learning Environment That Can Promote Grit, Tenacity, and Perseverance

Our research pointed to two major contextual factors that can promote grit, tenacity, and perseverance. First, students need to have the opportunity to take on long-term or higher-order goals (or purposes) that, to them, are "worthy" of pursuit. Second, they need a rigorous and supportive learning environment to help them pursue these goals. We now take a closer look at each of these.

Opportunity to Take on "Worthy" Long-Term or Higher-Order Goals

The complexity of grit, tenacity, and perseverance begins to unravel as we explore the different types of goals students can potentially take on throughout schooling. We begin with a cursory overview of the different types of potential goals and then examine two principles for what can make goals "worthy for students"—optimal challenge and alignment with their own interests.

Goals can be categorized on a variety of dimensions, many with extremely different implications for how to accomplish them. Example characteristics are as follows:

- **Developmental stage.** Goals and life concerns vary considerably for preschoolers, elementary school students, middle school students, high school students, postsecondary students, and adults. Students' age level is a key consideration in understanding goals and perseverance.

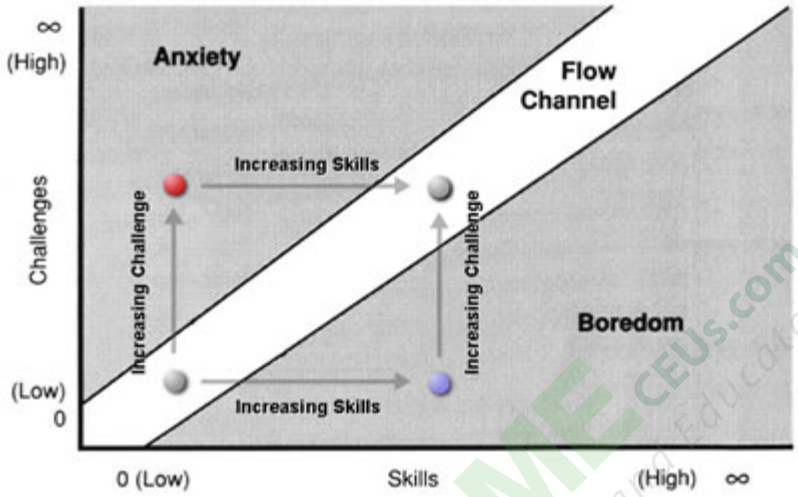
- **Timescale.** Goals can be relatively short-term, such as solving a difficult math problem; medium-term, such as studying for a test or completing a complicated inquiry-science project; or long-term, such as graduating from high school and being ready for college.
- **Complexity.** Independent of timescale, goals can have lesser or greater complexity. Becoming the National Spelling Bee champion and completing all of the educational milestones to become a STEM professional are both lofty long-term goals; however, the latter will likely require a more complex sequence of actions over time.
- **Academic content domain or setting.** If the goals are content-focused, they can differ depending on whether they are within math, science, language arts, an extracurricular activity, or some other content domain. For example, achieving deep understanding of the concepts of calculus requires different actions and supports than learning to shape the rhetoric of essays.
- **Nature of the reward and students' valuing of attaining the goal.** Goals can be motivated by intrinsic interests, extrinsic pressures for performance, and/or fear of failure. The same goal can be valued quite differently depending on the student. For example, for many students, getting into college is of extremely high value; it is less so for many students.

While there is a vast range of types of goals that students can take on, across many different research literatures, a common theme is that students are more likely to persevere in a productive manner when, to the student, the goals are worthy of perseverance.

Optimal challenge. One important principle is that students find goals "worthy" of pursuit when they are "optimally challenging"—they require some perseverance to succeed, but not so much so that they seem overwhelming or impossible. Many of the education experts we interviewed, as well as psychologists, game designers, sports experts, and others who deal with pushing people to do their best, discuss an optimal zone in which students can be motivated to engage in challenges that facilitate growth, with neither boredom nor anxiety. Csikszentmihalyi, in his 1990 book, *Flow: The Psychology of Optimal Experience*, explores optimal challenge, starting with the basic premise dating back to Aristotle that, more than anything else, people are driven to seek happiness. Based on a variety of empirical case studies, field studies, laboratory experiments, and historical analyses, he lays out a theory of "flow," the enjoyable and single-minded state of involvement with a task such that nothing else matters. Flow is a state that is so enjoyable that people will seek out and persist at tasks that evoke it for the sheer sake of doing it. Across a wide range of settings, he found some basic characteristics of tasks that tend to evoke flow. Exhibit 5 illustrates a set of principles for understanding such tasks. On the *x*-axis is the level of an individual's skills, and on the *y*-axis is the degree of challenge of an activity. When the individual has skills that exceed the challenge of the activity (i.e., shown in the lower right hand quadrant), she or he would be bored. When the activity is challenging in a way that exceeds the individual's skills (i.e., shown in the upper left hand quadrant), he or she would experience

anxiety. Optimal challenge occurs in the "flow channel" in which the individual's level of skill matches the challenge of the activity. According to flow theory, individuals are intrinsically motivated to seek out such optimal challenges and are most productive and motivated in the face of them.

Exhibit 5. Csikszentmihalyi's illustration of flow in the range of optimal challenge



Source: Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper & Row.

Importantly, when goals are focused on content learning, this theory suggests that perseverance can be evoked when students need to wrestle with new concepts. Even the lowest achieving students can potentially be "hooked" into perseverance when they are given a conceptually difficult problem that matches their skill level.

Alignment with specific interests or established values and goals. A second important principle is that students are likely see goals as "worthy" when they engage their interest and enthusiasm through alignment with specific interests or established values and goals. When students have opportunities to work toward goals that are meaningfully connected to their future success, cultural values, lives outside of school, and/or topics that are personally interesting and relevant, they are more likely to persevere when faced with challenge. In many cases, particularly with unfamiliar material, educators need to engage students in activities that bridge from their interests and familiar experiences to the learning objectives to help students attain more complex learning goals. Another related factor can be choice in the courses they take, the material they study, and the strategies they use to complete tasks, provided within the structure of limits and clear expectations.

A Rigorous and Supportive Learning Environment for Pursuing These Goals

When students have big and important goals, educators can promote perseverance by providing support. Just as there is an array of types of goals, there is also a wide variety of challenges, setbacks, obstacles, and adversities that students may encounter in pursuit of their goals. We first examine this variety of challenges, and then take a close look at two dimensions of learning environments that can be important for supporting perseverance.

There are a variety of different types of challenges and setbacks, many with extremely different implications for the resources necessary to persevere. Examples follow:

- **Conceptual complexity or lack of tactical knowledge.** When the goals are around learning content, many students are challenged by the conceptual complexity. Students may also be challenged by lack of tactical knowledge about how to handle new or large goals that require planning and monitoring, for example, a long-term inquiry-based science project or taking the steps necessary throughout high school to get into college.
- **More dominant distractions, lack of intrinsic motivation, boredom.** No matter how worthy a long-term goal may be, students will encounter particular subtasks or periods of time when other activities, such as surfing the Internet or hanging out with friends, may seem much more attractive in the short-term. Inevitably, students face choices about how they will spend their time and focus their attention.
- **Lack of resources.** Time, materials, and human resources can be essential for accomplishing many goals. Lack of resources can be a critical obstacle to a wide range of goals.
- **Adverse circumstances.** Students of all socioeconomic backgrounds may face adverse circumstances, such as illness, bullying, neighborhood violence, family difficulties, social alienation or racism, moving to a new school, and so on. It can be challenging to maintain focus and direction toward long-term goals in the face of such obstacles.

While these categories are not meant to be exhaustive, they begin to point to the types of resources that students will need as they face big goals. Here we discuss two dimensions—cultural and tangible resources.

Supportive and rigorous learning environment culture. The National Research Council 2003 report, *Engaging Schools: Fostering High School Students' Motivation to Learn*, includes an extensive review of the research literature on how to set up learning environments to support motivation for the nation's most vulnerable students. According to this report, cultures are supportive when they have the following characteristics: (1) they promote beliefs about competence, (2) they promote relevant values and goals, and (3) they promote social connectedness and belonging. Key principles are as follows:

- Students will persist more when they perceive that they are treated fairly and with respect, and adults show they care about them.
- Students will persist more when teachers, administrators, and others in the school environment have high expectations for students' success and hold students to high standards. These can be conveyed explicitly or implicitly. When remedial support is necessary, it is provided in ways that do not feel punitive or interfere with opportunities to engage in other interest-driven activities.
- Evaluation of student performance should be carefully designed not to undermine perceptions of competence and future expectations. It should be based on clearly defined criteria, provide specific and useful feedback, and be varied to give students opportunities to demonstrate competence in different ways.
- Extrinsic rewards and punishments that undermine intrinsic motivation should be avoided.
- Authoritarian discipline policies that limit students' options and opportunities for self-expression undermine intrinsic motivation and persistence.

Some of the alternative school models that we discuss in Chapter 4 have additional cultural components to promote grit, tenacity, and perseverance. For example, some schools are using models that provide explicit opportunities for practice, feedback and/or reflection on mindsets and skills that support perseverance. Other models provide extensive real-world projects that require planning and persistence to complete, and provide opportunities for iteration and continued improvement.

Tangible resources. Students are also more likely to persevere in learning environments that provide the tangible resources—materials, human, and time—necessary to overcome challenges and accomplish their goals. Depending on the type of goals, materials can include access to particular programs, technology, rigorous curriculum, equipment or materials to complete projects, course tuition, or physical facilities where students can do their work. Human resources can include mentoring, tutoring, peer guidance, teachers with particular training, or special services. Time can also be a precious resource—in optimal challenge, students need to have adequate time to grapple with their difficulties, reflect, get feedback, iterate, and try new approaches.

Particularly in high-poverty urban areas, many of these tangible resources can be lacking. Teachers may not have adequate materials or professional development, or they may have to handle so many students that they simply do not have time to provide support to individual students. As we will discuss later, there are important potential new roles for technology in filling some of these gaps and implications for policy and resource needs.

Psychological Resources That Can Promote Grit, Tenacity, and Perseverance

We turn now to the psychological resources within students that support their perseverance. Of course, it is not all up to the student—learning environments need to be designed to teach and/or promote these resources. Many of the principles discussed above about setting up productive learning cultures target these resources within students, and we will explore specific interventions in Chapter 4. In the following sections, we examine the three major categories of psychological resources in the model—academic mindsets, effortful control, and strategies and tactics.

Academic Mindsets

Academic mindsets are the psychological resources necessary for students to productively frame themselves as learners, their learning environment, and their relationships to the learning environment. These include beliefs, attitudes, dispositions, values, and ways of perceiving oneself. Compelling evidence from a variety of sources suggests that mindsets can have a powerful impact on academic performance in general, and in particular for how students behave and perform in the face of challenge. For example, Blackwell, Trzesniewski, & Dweck (2007) showed that teaching middle school students to have a "growth mindset"—the belief that intelligence is malleable and grows with effort—had a significant positive impact on academic achievement.

The research literature on academic mindsets can be divided into three main categories, parallel to those that characterize supportive learning environments: (1) beliefs about competence, (2) values and goals, and (3) beliefs about social connectedness and belonging. In our hypothesized model in Exhibit 4, building on the work of Farrington et al. (2012), we represent mindsets across each of these categories as first-person statements from the point of view of a student. Here we discuss the commonsense notions that each of these beliefs represent and the availability of research to back its importance. For more detail, see recent literature reviews that have examined the relationships between mindset and academic performance (e.g., Dweck et al., 2011; Yeager & Walton, 2011; Snipes et al., 2012; Farrington et al., 2012).

- *I can succeed at this.* When students have strong self-efficacy (belief in their ability to learn and perform well) and high expectations for success, they are more likely to persevere in the face of challenge (e.g., Bandura, 1997; Schunk & Pajares, 2009). These beliefs can be stronger predictors of success than measured levels of actual ability and prior performance.
- *My ability and competence grow with my effort.* Beliefs about ability and expectations for success can be fragile, especially when students face a new challenge they have never encountered before. Research by Dweck and colleagues points to the importance of a "growth mindset," the belief that ability is malleable and can be increased with effort and

learning (Dweck & Leggett, 1988). This is contrasted with a "fixed mindset," the belief that ability is a fixed quantity that one either possesses or does not. When faced with academic tasks that are routine and do not entail challenge, students with fixed and growth mindsets tend to exert similar effort. However, when tasks become challenging, students with growth mindsets are more likely to persist. Studies have also shown that these mindsets themselves can be malleable and that, when students are taught to have a growth mindset, they are more successful academically (Blackwell et al., 2007).

- *Challenge is inevitable for success.* Part of developing resilience in the face of challenge is understanding that challenges are inevitable and not an indication of personal failure. A theme that came up in some of our interviews is that many students, both higher and lower achieving, experience a breakdown when they encountered some of the inevitable challenges of schooling—such as increasing difficulty and abstractness of concepts, and decreasing structure in the middle grades, and need for new strategies for success. Intervention studies have shown that students can be taught to attribute challenge to external factors that are "bumps in the road" rather than limitations in their own level of ability (e.g., Wilson & Linville, 1985; Walton & Cohen, 2007; Cohen et al., 1999).
- *This work is in line with my interests, values, or goals.* There is an extensive body of research showing that students will persevere more in the face of challenge when tasks have value for them—they find them interesting or see them as serving short- or long-term goals that are important to them. Students may need support in knowing how to connect the dots between the work they are doing and the purposes it may serve in their lives, or support in discovering and fostering interests.
- *I belong in this academic community.* Extensive research shows that when students feel a sense of belonging in their school and classrooms—through relationships with peers, teachers, and other adults—they are more likely to engage in schooling. Students' sense of belonging is closely tied to their perceptions of competence and autonomy, intrinsic motivation, and willingness to adopt established norms and values (e.g., Osterman, Johnson, & Bybee, 2000). There is growing consensus that the nature and quality of students' relationships with their teachers and peers play critical roles in engaging students to learn (Wentzel, 2009; Ladd, Herald-Brown, & Kochel, 2009). Feelings of lack of trust, respect, or fairness from teachers or alienation and rejection from peers can be a strong determinant of disengagement from school.

While these mindsets are important for all student populations, as we discuss above, traditionally underserved students may be at particular risk of having unproductive mindsets around competency, growth, and belonging. In Chapter 4, we will discuss several interventions that target the development of productive mindsets for various student populations.

Effortful Control

In Angela Duckworth and colleague's (2010) study of National Spelling Bee champions, they summed up the findings as follows:

> Deliberate practice—operationally defined in the current investigation as the solitary study of word spellings and origins—was a better predictor of National Spelling Bee performance than either being quizzed by others or engaging in leisure reading. With each year of additional preparation, spellers devoted an increasing proportion of their preparation time to deliberate practice, despite rating the experience of such activities as more effortful and less enjoyable than the alternative preparation activities. Grittier spellers engaged in deliberate practice more so than their less gritty counterparts, and hours of deliberate practice fully mediated the prospective association between grit and spelling performance (p. 178).

In essence, the most successful competitors were those whose passion for the long-term goal of the National Spelling Bee championship led them to persist with less intrinsically rewarding, but more effective, practice strategies (Duckworth et al., 2011).

Throughout the course of education (and in life), students are constantly faced with tasks that are important for long-term goals but that in the short-term may not feel desirable or intrinsically motivating, especially in comparison to other ways they could spend their time. Even the most thoughtfully designed, inquiry-based, emotionally supportive learning environment will have its share of homework assignments that need to supersede, for example, playing games with friends. Duckworth and colleagues point out that as far back as 1899, William James asserted that some school work will be "repulsive and cannot be done without voluntarily jerking back the attention to it every now and then" (p. 179).

Duckworth has written extensively about psychological resources that enable students to persist at such tasks and that are predictive of academic success—self-discipline and self-control. While colloquial and research definitions of these vary widely, they can be boiled down to some key facets. Duckworth (2009) conceptualizes self-discipline as "the ability to marshal willpower to accomplish goals and uphold standards that one personally regards as desirable. That is, self-discipline isn't the capacity to do what other people order you to do; rather, it is the capacity to do what you want to do. It's knowing how to manage your emotions and thoughts, and knowing how to plan your behavior so you can reach your goals" (p. 536). She conceptualizes self-control in terms of executive functions—the ability to control and regulate attention in the face of distractions, and the ability to inhibit inferior but strong impulses (e.g., surfing the Internet) to act on superior goals (e.g., completing homework assignments) (Duckworth, 2011). Similarly, she includes delay of gratification in the conceptualization of self-control (Duckworth & Kern, 2011).

While self-discipline and self-control can seem like austere qualities, Duckworth emphasizes that they actually contribute to not only greater academic achievement but also greater well-being in general. For example, she cites the classic "marshmallow studies" by Walter Mischel in which preschoolers chose between eating one marshmallow right away and having two if they could wait. They found that the amount of time preschoolers could delay the impulse to eat a marshmallow placed in front of them was correlated not only with their SAT scores many years later, but also their emotional coping skills in adolescence (Mischel, Shoda, & Rodriguez, 1989). She later replicated this study and extended it to show that children who waited longer were happier, more relaxed, and better at handling stress (Duckworth, 2009).

A natural question to ask is to what extent self-discipline and self-control are personality traits that are fairly stable over time or context, and to what extent they entail skills that can be developed. This question has been examined from multiple perspectives, ranging from longitudinal studies that track individuals over time or across contexts, to studies that have introduced interventions to alter executive function. As for most fundamental personality characteristics, evidence suggests that there can be powerful influences from both individual temperamental tendencies and situational factors, and that these capacities can be cultivated. For example, Moffit and colleagues (2011) show some longitudinal stability of self-control over time with long-term implications for physical health, substance dependence, personal finance and criminal offenses. Tsukayama, Duckworth, and Kim (2011) show that how impulsively individuals act within specific situations may be more closely related to how tempting they find specific impulsive behaviors rather than their general impulsivity.

As we discuss in Chapter 4, there are a number of successful interventions for developing executive functions for children in preschool and elementary school.

Strategies and Tactics

No matter how productive their mindsets and focused their attention, students are more likely to persevere when their psychological resources include a toolkit of specific strategies and tactics to deal with challenges and setbacks. Moving into adulthood, such a toolkit will be important for the 21st-century workplace in which conditions tend to evolve rapidly and require complex, long-term collaborative problem-solving. Individuals need actionable skills for taking responsibility and initiative, and for being productive under conditions of uncertainty. For example, in our interview with executive talent developer Denise Brosseau, she emphasized that in the economic downturn in the early 2000s, the entrepreneurs who had the strongest strategies and tactics for dealing flexibly with adversity were the most likely to continue to thrive.

We turn here to the research literatures on learning strategies, self-regulated learning, and metacognition. As Farrington et al. (2012) discuss, there is no single agreed-upon model for what the various learning strategies are, how they can be measured, their impacts on learning, or how

they should be taught. However, there are many general themes that cut across the literature. For an extensive review, see the *Handbook of Metacognition in Education* (Eds. Hacker, Dunlosky, & Graesser, 2009).

One general theme in the literature is that learning strategies encompass multiphase processes, involving some combination of goal-setting, planning, enacting, monitoring progress, and adjusting enactment. Exhibit 6 lays out a general four-phase model of learning strategies to support perseverance in the face of challenge. The phases are drawn from Winne and Hadwin's (1998) model of self-regulated learning and are adapted specifically for perseverance, drawing on additional work by Snipes et al. (2012), Farrington et al. (2012), and Duckworth, Grant, Lowe, Oettingen, & Gollwitzer (2011). Phases are recursive, not necessarily linearly executed.

Exhibit 6. A general model of learning strategies to support persistence in the face of challenge

Phase	Name	Examples of types of strategies and tactics
1	Definition of Task	Construct full definition of the task. Consider what is known and unknown about it. Consider how difficult it will be and potential challenges.
2	Goals and Plans	Set specific goal(s). Set specific criteria for knowing when goal(s) are achieved. Formulate specific actionable plans to achieve goal(s). Formulate tactics for dealing with challenges.
3	Enactment and Monitoring	Structure the environment so that it is favorable for executing plans. Execute plans. Manage time. Seek new information. Organize information and resources. Seek assistance from other people. Monitor progress relative to criteria for meeting goal(s). Adjust course of actions as necessary.
4	Deliberation and Adaptation	Deliberate on effectiveness of plans and strategies. Reformulate task, goals, conditions, strategies, plans.

Source: Adapted from Winne, P. H., & Hadwin, A. F. (1998). Studying as self-regulated learning. In D. J. Hacker, J. Dunlosky & A. C. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 277–304). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Perseverance for any given goal may call for a particular subset of these phases and strategies. For example, in solving a difficult math problem, the task and goals may be well defined already, but monitoring of progress and adjusting courses of action may be essential. For a medium-term goal, such as completing a collaborative inquiry-based science project, and longer-term goals,

such as graduating high school, many of these steps may be important and need to be revisited in an ongoing manner.

Chapter 4 discusses interventions, both digital and nondigital that provide structures and supports for students to engage in these types of practices in different contexts. Various models emphasize different aspects of this overall flow.

The Hypothesized Model as a Whole

Now that we have laid out the research around each of the facets we consider the model as a whole. It is important again to emphasize this model is hypothesized and further research is necessary to understand these dynamics in a wide variety of school settings for a diversity of students.

The model highlights important contextual factors that can be extremely potent for promoting or undermining perseverance. The context can shape the types of goals students will set for themselves, the challenges and setbacks they may face, the presence of their psychological resources, and, in turn, their perseverance. No learning environment will have all of the supportive qualities outlined here, nor are they all necessary in a given circumstance to optimally shape perseverance. Careful attention must be given to particular student populations who face so many specific barriers to perseverance, due to socioeconomic conditions, local culture and values, and resources available.

Depending on both the nature of the goals and the nature of the challenges or setbacks, perseverance may require students to draw on different psychological resources at different times and to leverage them in different ways. For example, in working on a difficult math problem, students may need to encourage themselves with a growth mindset as they struggle conceptually. In working on a collaborative, open-ended inquiry science project, students may need to rely on strategies and tactics for getting the job done on time. When getting through the long haul of a challenging high school course necessary to get into college, students may need to keep exerting effortful control to get their assignments done rather than do other less productive but more attractive activities.

Similarly, each of the psychological resources can dynamically influence each other. For example, students' cognitive framing of their own ability can be closely tied to their capacity—and perhaps, more importantly, their *desire*—to control their attention in the face of distraction. In other words, when students do not have a sense that success is possible, they may not be motivated to persevere with the effort it would take to be successful. Likewise a students' toolkit of strategies and tactics can directly influence how confident they feel when faced with a challenge and how likely they are to exert the effort necessary to persevere. Academic mindsets

can similarly impact whether students seeks out strategies and tactics when they are stuck. For example, if students have a "fixed mindset" of intelligence, it may appear to them that they are inherently flawed, and therefore they would not seek out the resources to establish new ways of tackling difficult problems.

The Dark Side of Grit: Potential Costs and Risks

An important theme that emerged in many interviews and in the literature is that grit can have a "dark side." It is not necessarily always productive and can have costs and risks—especially in this accountability-driven climate and in communities that place extremely high expectations on students. While little research has examined this to date, some speculations encountered were as follows:

- Persevering in the face of challenges or setbacks to accomplish goals that are extrinsically motivated, unimportant to the student, or in some way inappropriate for the student can potentially induce stress, anxiety, and distraction, and have detrimental impacts on students' long-term retention, conceptual learning, and psychological well-being.
- As grit becomes a more popular notion in education, there is a risk that poorly informed educators or parents could misuse the idea and introduce what psychologists call the "fundamental attribution error"—the tendency to overvalue personality-based explanations for observed behaviors and undervalue situational explanations. In other words, there is a risk that individuals could overattribute students' poor performance to a lack of "grittiness" without considering that critical supports are lacking in the environment.
- Perseverance that is the result of a "token economy" that places a strong emphasis on punishments and rewards may undermine long-term grit; in particular, while these fundamentally manipulative supports can seem to "work" in the short-run, when students go to a different environment without these supports, they may not have developed the appropriate psychological resources to continue to thrive.
- In our interview with psychologist Carol Dweck of Stanford University, she discussed an emerging trend that many undergraduate students have developed the expectation that their decisions about their studies and professional direction must come from an inherent "passion"—rather than through the effort and work of fully engaging in what they are doing. While a rare few may be driven by specific passions, for many students, this expectation is false and can undermine their persistence when they begin to encounter challenges in a chosen direction.

Theoretically, there may be important links to the rich and extensive achievement orientation literature that makes distinctions between "mastery-oriented" goals and "performance-oriented" goals. Little systematic research has investigated these links to date. Careful research in this area

is necessary to help educators learn how to protect students and to gauge and fine-tune practices and interventions.

Moving Forward

As practitioners, researchers, and policymakers, we have the opportunity and responsibility to develop ways to interrupt negative cycles and provide learning environments that teach and/or promote grit, tenacity, and perseverance for the wide diversity of students and the wide range of challenges they will face. Students may need or benefit from intervention at any or all of these points—opportunities to take on worthy goals, a rigorous and supportive learning environment, and/or opportunities to engage or develop supportive psychological resources. The next chapters explore measurement and interventions.

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Measuring Grit, Tenacity, and Perseverance

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To design and evaluate learning environments that effectively promote and/or teach grit, tenacity, and perseverance, the field will need valid and reliable measurement instruments that can provide quick and useful feedback. Assessment can serve a wide range of purposes well beyond accountability. It can provide the instrumentation needed for research to understand grit, practical tools for educators and learners, tools for program design and evaluation, and diagnostic indicators for vulnerable students. Historically, there has been much greater attention to measuring and assessing cognitive competencies, leaving a gap in the field's methods for assessing the intrapersonal and interpersonal competencies. One challenge in measuring grit, tenacity, and perseverance is the diversity of underlying constructs and how they may be operationalized and used in theory, practice, and measurement. As discussed in Chapter 2, grit comprises factors that are complex, have multiple components, can be highly context-specific, and can look different at different age levels. Another challenge is navigating the broad spectrum of measurement methods and techniques, ranging from self-report, to observational, to physiological—each with a substantial set of advantages and trade-offs.

However, the field has already made tremendous progress in this area and is well positioned to continue. There are strong theoretical and empirical research bases around the various facets of grit, tenacity, and perseverance. Furthermore, there are substantial opportunities in the broad spectrum of measurement methods and techniques. With the prevalence of new digital learning resources and learning technologies, new forms of measurement are emerging, making it possible to go beyond conventional approaches. For example, data mining techniques can track students' trajectories of persistence and learning over time, thereby providing actionable feedback to students and teachers. In addition, functional Magnetic Resonance Imaging (fMRI) and physiological indicators offer insight into the biology and neuroscience underlying observed student behaviors.

Ultimately, the field needs valid and reliable measurement tools for a range of purposes. At the same time, how we measure and interpret student performance on these skills potentially can have significant implications and consequences for individual students and institutions. Thus, it is important to make assumptions about measurement explicit and explore ethical considerations.

This chapter provides a brief overview of the landscape of current approaches to measuring the various factors comprising grit, tenacity, and perseverance, emphasizing emerging measurement paradigms. It begins by laying out the various purposes of assessing grit, tenacity, and perseverance. The chapter then provides an overview of the underlying constructs and measurement methods. It concludes with a discussion of evidence-centered design (ECD) as a high-leverage design methodology.

Key Challenges

- Historically, a greater emphasis on measuring cognitive competencies has left a wide gap in the field's methods for assessing intrapersonal and interpersonal competencies.
- There is a diversity of underlying constructs and how they are operationalized and used in theory, practice, and measurement.
- There is a need to navigate the broad spectrum of measurement methods and techniques, each with a substantial set of advantages and trade-offs.

Essential Measurement Terminology

Adapted from the Standards for Educational and Psychological Testing (AERA, APA, NCME, 2001, pp. 173-184)

Construct. The concept, characteristic, skill, competency, or attitude that a test is designed to measure.

Operationalization. The process of strictly defining variables into measurable factors.

Validity. The degree to which accumulated evidence and theory support specific interpretations of test scores entailed by proposed uses of a test.

Reliability. The degree to which test scores for a group of test takers are consistent over repeated applications of a measurement procedure and hence are inferred to be dependable and repeatable for an individual test taker; the degree to which scores are free of errors of measurement for a given group.

Why Measure Grit, Tenacity, and Perseverance?

There are many different practical purposes for measuring these constructs that can directly impact the effectiveness of learning environments in promoting grit, tenacity, and perseverance. Each purpose can have important implications for the types of measurement methods that will be available and practical, the consequences of the findings of these measures, the level of rigorous validation necessary for their intended use, and the populations on which the measures should be validated. While all measures must be grounded in theory and subjected to empirical validation methods, here we discuss some particular considerations for each different purpose.

- **Practical tools for educators and learners.** Measures to serve these purposes need to be usable and robust across settings. They need to provide metrics that are readily interpretable and actionable, as well as appropriate to the educational settings in which they are used. Design of instruments must include consideration of educators as the end user.
- **Tools for program design and evaluation.** Measures to serve these purposes must be aligned with learning theories, goals, and trajectories, and should be developed in parallel with logic models for how interventions may impact the key constructs. The NRC report on 21st-century competencies speaks to the centrality of measurement in the development of interventions:

  > Designers and developers of instruction targeted at deeper learning and development of transferable 21st-century competencies should begin with clearly delineated learning goals and a model of how learning is expected to develop, along with assessments to measure student progress toward and attainment of the goals (NRC, 2012, p. Sum-7).

- **Instrumentation for research to understand grit, tenacity, and perseverance.** Measures to serve this purpose must be clear in their operationalizations so that their interpretations can support new insights into the processes and facets related to these skills.
- **Diagnostic indicators for vulnerable students.** Measures to serve this purpose, such as those in early-warning systems, can have significant consequences for individual students, who may or may not receive services or special attention based on these indicators. Designers of such systems must be particularly attentive to "consequential validity" (i.e., evidence from intended and unintended consequences of using the data), and ensure that all assumptions and criteria are explicit and that users can be well-trained in appropriate data use and disclosure.

Overview of the Measurable Constructs

In Chapter 2, we defined *grit* for the purpose of this report as: "Perseverance to accomplish long-term or higher-order goals in the face of challenges and setbacks, engaging the student's psychological resources, such as their academic mindsets, effortful control, and strategies and tactics." Depending on the purposes, measurement of grit may target one or more of these factors.

Does Measuring "Dispositions" Imply They Are Unchangeable Traits?

Some people equate "dispositions" with traits that people are born with and cannot change. In this brief, and particularly in this section on measurement, we use the term "disposition" to mean enduring tendencies, independent of any claims about their origin or malleability. We consider dispositions to be enduring tendencies that can be the result of any number of factors in the environment or the individual's innate temperament. We also make no general claims here in either direction about whether dispositions are changeable, malleable, or teachable—malleability will be highly dependent on what the disposition is and the nature of the opportunities that individuals encounter.

At the center of the model, measurement may target whether and/or how an individual perseveres toward a goal in the face of challenges and setbacks. ***An important distinction for measurement purposes is whether perseverance is conceptualized as a disposition or set of processes.*** If conceptualized as a *disposition*, the measurement may target perseverance as a general or enduring tendency to persevere (see callout box for more detail on how we conceptualize "disposition"). For example, Duckworth et al. (2007) ask individuals to report about their enduring dispositional tendencies around pursuing long-term goals and then examine relationships among self-reported perseverance, academic performance, and goal attainment. These types of measures can be used for research purposes to understand how these tendencies relate to performance or attainment, as well as to provide important information to students, teachers, and parents about students' tendencies and preferences. If perseverance is conceptualized as a *set of processes*, its measurement may focus on the sequence of behaviors, emotions, physiological reactions, and/or thoughts that unfold over time during the process of learning. For example, researchers such as Shute and Ventura (in press), Feng, Heffernan, and Koedinger (2009), and Arroyo and Woolf (2005) focus on "micro-level" moment-by-moment behaviors in the process of solving problems. These types of measures can be used in classrooms or within digital learning environments to provide feedback to teachers and students during learning. While dispositional and process approaches each tap into perseverance, their underlying constructs are conceptually distinct, have different underlying assumptions, and require different methodologies (e.g., self-report versus log file analysis). ***An important area for future research is understanding connections between enduring dispositions and "micro-level" process factors.***

Measurement may also target—and often does—aspects of the classroom climate and/or the psychological resources that contribute to and interact with perseverance: academic mindsets, effortful control, and strategies and tactics. Yet, these broad categories just scratch the surface. Underlying each is a constellation of multiple, distinct skills and attributes, which can be

measured. Further, these resources can also be conceptualized in terms of dispositions or processes. Measuring academic mindsets, for instance, could involve assessing beliefs about effort and intelligence, academic goals, or feelings of belonging. Similarly, measuring effortful control could involve examining executive functions, self-discipline, self-control, or delay of gratification, each of which has important differences. Strategies and tactics reflect both ability to plan and ability to monitor goals and progress. Many measures also capture the protective factors and positive assets that can contribute to students' resilience in the face of adversity. Thus, in measuring these psychological resources, it is important to understand that they are multifaceted and require specific questions or techniques for each component skill or attribute.

Measurement Approaches: Methods, Examples, and Tradeoffs

This section reviews the major approaches to measuring these constructs—self-report, informant report, school records, and behavioral task performance. For each approach, we describe the method or methods involved, discuss some illustrative examples, and lay out tradeoffs of the approach. There is no "right" answer or best approach; rather, different methods will be relevant depending on the purposes of measurement, the context of measurement, and the resources available. As each method captures different facets of these constructs and has particular advantages and disadvantages, it can often be expedient to "triangulate" among multiple methods.

Self-Report

Methods. Perhaps the most familiar and widely used measurement approach for noncognitive factors is self-report. In such measures, participants typically respond independently to a set or sets of items that ask for ratings of their perceptions, attitudes, goals, emotions, and beliefs. Self-report can be used to measure *dispositional* constructs. For example, researchers can examine consistency in participant's ratings to determine the strength of the belief or skill. Self-report can also be used to measure *process* constructs; for example, in the Experience Sampling Method (ESM), participants typically carry around a handheld device that "beeps" them at random intervals, prompting self-report of experiences in that moment (e.g., Hektner, Schmidt, & Csikszentmihalyi, 2007). Such data can be used to make inferences about emotions, thoughts, and behaviors within and across specific situations.

Some example measures. Here we discuss a handful of well-known and well-validated instruments. For comprehensive reviews of self-report instruments in these domains, see Atkins-Burnett, Fernandez, Akers, Jacobson, and Smither-Wulsin (2012), Duckworth and Kern (2011), Hoyle and Davisson (2011), Dweck et al. (2011), and Snipes et al. (2012). As a first example, Exhibit 7 shows Duckworth et al.'s (2007) validated self-report Grit Scale measure. These

researchers have examined how a wide range of student and adult populations respond to these types of items, examining correlations with other variables. Exhibit 8 shows Dweck, Chiu, and Hong's (1995) scale to assess an individual's implicit *Theory of Intelligence* as fixed or subject to growth with effort. This scale has been used in a many research studies over two decades, demonstrating key differences in how individuals with growth versus fixed mindsets deal with challenges. Another example is the *Self-Regulation Questionnaire*, a 63-item self-report assessment about facets of strategies and tactics (e.g., formulating a plan, implementing a plan, assessing the effectiveness of a plan) (Brown, Miller, & Lawendowski, 1999). Also, we learned in our interview with Professor Camille Farrington of the University of Chicago Consortium for Chicago Schools (the same group that released the Raikes Foundation-funded review of the literature on noncognitive factors) that her group is currently developing self-report instruments for teachers and students to measure all of the reviewed noncognitive factors at the same time—academic behaviors, academic perseverance, social skills, academic mindsets, and learning strategies. This new set of measures will allow researchers to examine important relationships among these factors. Additionally, commercial products such as the VIA Character Strengths Inventory (http://www.viacharacter.org) and the Clifton StrengthsFinder (http://www.strengthsfinder.com) can be used to help individuals identify core enduring strengths, of which grit is one of many.

Exhibit 7. Items from a self-report measure of Grit

Consistency of Interest Scale [a]
1. I often set a goal but later choose to pursue a different one.
2. New ideas and new projects sometimes distract me from previous ones.
3. I become interested in new pursuits every few months.
4. My interests change from year to year.
5. I have been obsessed with a certain idea or project for a short time but later lost interest.
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.
Perseverance of Effort Scale
1. I have achieved a goal that took years of work.
2. I have overcome setbacks to conquer an important challenge.
3. I finish whatever I begin.
4. Setbacks don't discourage me.
5. I am a hard worker.
6. I am diligent.

[a] Higher score reflects lower consistency of interest; item was reverse scored to create scale.

Source: Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology, 92*(6), 1087–1101.

Exhibit 8. Items from a self-report measure of Theory of Intelligence ("fixed" versus "growth" mindset)

1. You have a certain amount of intelligence and you really can't do much to change it.
2. Your intelligence is something about you that you can't change very much.
3. You can learn new things, but you can't really change your basic intelligence.

Note: More information is available at www.mindsetonline.com.

Source: Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. *Psychological Inquiry, 6*(4), 267–285.

Methodological tradeoffs. Practically speaking, self-report surveys have the advantages of being easy to administer to large numbers of students, and data from surveys often can be interpreted with conventional statistical methods. Numerous studies show that well-constructed and well-validated self-report instruments can capture facets of dispositions and experiences that are closely aligned with behaviors and other performances. There are, however, several challenges, both theoretical and methodological, with self-report surveys. Self-report is troubling to many researchers because people are not always valid assessors of their own skills (Jones & Nisbett, 1971; Maki, 1998; Winne et al., 2006). For example, people often claim to have skills that they do not have when the skills are valuable and desirable. Moreover, the explicitness of targeted skills as asked in surveys may compromise an intervention designed to promote these skills. Surveys can be lengthy and disruptive to complete in learning environments. They often contain multiple questions about the same idea for validity and reliability purposes and can interrupt students' thinking if completed mid-task. Alternatively, if completed post-task or at the conclusion of an experience or course, they require students to recall their perceptions, potentially introducing failures of memory. Surveys may not be sensitive enough to detect changes over time or across situations, possibly contributing to false assumptions about their relative stability within and/or across contexts. Finally, surveys like the one in Exhibit 8 may be highly context-specific and lead to different responses depending on context.

Informant Reports

Methods. Informant reports are those made by someone other than the student him or herself. Typically, these are conducted by teachers, parents, or observers who are visiting or watching video of the classroom as researchers or evaluators. Given the frequent interactions around learning that teachers have with individual students on an ongoing basis, teachers are in a unique position to provide important judgments and feedback about students' grit, tenacity, perseverance, and other psychological resources. Observers can visit the classroom and talk to students, applying specific rubrics and providing the "objective" feedback of well-trained eyes not involved in the day-to-day routines of the classroom.

Some example measures. Teacher report emerged in our interviews as an important method for measuring constructs around grit, tenacity, and perseverance. For example, KIPP and other character education programs have been developing methods of using explicit teacher feedback to help students gauge their level of grit with respect to specific criteria and to open up conversations among parents, teachers, and students (see Chapter 4 for more details about these models). These schools have been implementing a "Character Report Card" on which students receive ratings pooled from multiple teachers on factors such as grit and self-control. Exhibit 9 illustrates what such a report card might look like. It is important that these ratings come from multiple teachers, as they are then less susceptible to biases of particular relationships. KIPP has been facilitating the use of these Report Cards with a technology called PowerTeacher that allows teachers to input their ratings online. Informant reporting is also a common approach for teachers, parents/guardians, and mental health professionals to assess the social-emotional competencies that serve as protective factors associated with resilience in young children. For example, the Devereux Student Strengths Assessment (DESSA; LeBuffe, Shapiro & Naglieri, 2009) can be used for children in kindergarten through eighth grade (ages 5-14). The DESSA is a 72-item, standardized, norm-referenced behavior rating scale that focuses on student strengths and positive behaviors related to eight dimensions: self-awareness, social awareness, self-management, goal-directed behavior, relationship skills, personal responsibility, decision making, and optimistic thinking. It can be used for screening, profiling for intervention, and monitoring and measuring change (Hall, 2010).

While we did not find classroom observation protocols that measure grit, tenacity, or perseverance per se for individual students, there are protocols that measure related constructs, such as engagement. An example of a validated classroom observation protocol targeting students' engagement is presented by Skinner, Kindermann, and Furrer (2009). This protocol examines elementary school students' behavior, characterizing it as actively on-task, passively on-task, or off-task. Such a measure could be used during challenging tasks to examine students' perseverance.

Exhibit 9. Example of Character Report Card for one hypothetical student

KIPP:CHARACTER REPORT CARD

Jane Smith Grade: 8	KIPP Imagine Date: 01/28/11	Q2	Q2					
	OVERALL SCORE	**4.30**	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 5	Teacher 6
Zest		4.28						
1	Actively participates	4.50	4	5	5	4	4	5
2	Shows enthusiasm	4.17	5	4	3	4	4	5
3	Invigorates others	4.17	3	4	5	4	5	4
Grit		4.11						
4	Finishes whatever he or she begins	4.00	4	5	3	4	4	4
5	Tries very hard even after experiencing failure	4.17	5	4	4	3	4	5
6	Works independently with focus	4.17	4	4	3	4	5	5
Self Control – School Work		**4.33**						
7	Comes to class prepared	4.50	4	5	5	5	4	4
8	Pays attention and resists distractions	4.50	4	5	4	5	4	5
9	Remembers and follows directions	4.17	4	5	5	4	3	4
10	Gets to work right away rather than procrastinating	4.17	5	4	4	4	3	5
Self Control - Interpersonal		**4.54**						
11	Remains calm even when criticized or otherwise provoked	4.50	4	5	4	5	5	4
12	Allows others to speak without interruption	4.83	5	5	5	4	5	5
13	Is polite to adults and peers	4.50	4	5	4	5	4	5
14	Keeps his/her temper in check	4.33	4	5	4	4	5	4
Optimism		4.25						
15	Gets over frustrations and setbacks quickly	4.33	5	4	4	4	5	4
16	Believes that effort will improve his or her future	4.17	5	4	4	3	4	5
Gratitude		4.25						
17	Recognizes and shows appreciation for others	4.17	4	4	5	4	5	3
18	Recognizes and shows appreciation for his/her opportunities	4.33	5	4	5	3	4	5
Social Intelligence		**4.33**						
19	Is able to find solutions during conflicts with others	4.17	4	4	3	5	4	5
20	Demonstrates respect for feelings of others	4.50	5	4	4	4	5	5
21	Knows when and how to include others	4.33	5	4	4	4	5	4
Curiosity		**4.28**						
22	Is eager to explore new things	4.17	5	4	3	4	5	4
23	Asks and answers questions to deepen understanding	4.50	5	4	5	4	4	5
24	Actively listens to others	4.17	4	4	5	4	5	3

SCALE

1= Very much unlike the student
2= Unlike the student
3= Somewhat like the student
4= Like the student
5= Very much like the student

Methodological tradeoffs. Using classroom observation protocols and reports from teachers or other professionals addresses concerns regarding bias in self-report, and informant reports can be particularly helpful for ascertaining intrapersonal competencies in young children. If observers are able to consistently judge behaviors and interactions, observation protocols can be valuable for evaluating the characteristics of exchanges among students and teachers, how students interact with tools, student affect, or whether they are applying learning strategies or sticking with a task. Collecting and analyzing enough observation data to draw generalizable conclusions is resource intensive as systematic analyses of observation data may require video recording, training of observers to evaluate behaviors and interactions consistently, and time to complete the observations and coding. Observational approaches also can present challenges in capturing information about an individual's mindset, which is less directly observable, and affect, which can be difficult to judge.

School Records

Methods. Another source of data about students' perseverance is school records about grades, standardized test scores, attendance, dropping-out, discipline problems, social services used, and so on. The *Expanding Evidence* report points to important trends in the availability and application of technology-supported institutional-level data for supporting at-risk students (U.S. Department of Education Office of Educational Technology, 2013). Data at the institutional level is becoming increasingly streamlined and cross-referenced, improving the capacity to link student data within and across systems.

Some example measures. One example is the Youth Data Archive (YDA) at the Gardner Center at Stanford University, which links data across systems—school, social services, foster care, youth development programming, juvenile justice—to provide actionable integrated student profiles to educators. Another example is the use of interest-driven badging systems, for example, Mozilla Open Badges (http://www.openbadges.org), to recognize in and out of school learning and accomplishments.

Methodological tradeoffs. Data from school records provides new possibilities for rich longitudinal analyses of educational impacts, as well as for informing early warning systems that can be used to identify students who are not managing to persevere in the face of all of the challenges of schooling. These records, however, are only broad indicators of perseverance and do not tell the richer story of an individual's characteristics or how an individual's interactions with features of the learning environment contribute to these outcomes.

Behavioral Task Performance—Conventional Approaches and New Opportunities

Methods. Behavioral task performance measures are the broad set of methods used to capture behaviors consistent with perseverance or lack thereof—and in many cases, associated emotional experiences, physical movements or facial expressions, physiological responses, and thoughts—that students do in response to a particular challenge. These methods primarily provide insight into *processes* associated with perseverance as learning or other challenging tasks unfold. Behavioral task performance can be elicited in a range of contexts, such as a laboratory experiment, the classroom, an informal learning setting, or a digital learning environment.

While laboratory experiments have examined behavioral task performance for many years, new technological opportunities offer potential for new methods and approaches. *Educational data mining* (EDM) and *learning analytics* within digital learning environments allow for "micro-level" analyses of moment-by-moment learning processes (see callout box).

Student data collected in online learning systems can be used to develop models about processes associated with grit, which then can be used, for example, to design interventions or adaptations to a learning system to promote desirable behaviors. Dependent behavioral variables associated with a challenge at hand may include responses to failure (e.g., time on task, help-seeking, revisiting a problem, gaming the system, number of attempts to solve a problem, use of hints), robustness of strategy use (e.g., planning, monitoring, tools used, number of solutions tried, use of time), level of challenge of self-selected tasks, or delay of gratification or impulse control in the face of an enticing off-task stimulus. Such data can be examined for discrete tasks or aggregated over many tasks.

The field of *affective computing* is also emerging (see callout box for definition). Researchers are exploring how to gather complex affective data and generate meaningful and usable information to feed back to learners, teachers, researchers, and the technology itself. Connections to neuroscience are also beginning to emerge.

New Methods for Measuring Behavioral Task Performance

Educational data mining (EDM) "develops methods and applies techniques from statistics, machine learning, and data mining to analyze data collected during teaching and learning. EDM tests learning theories and informs educational practice" (U.S. Department of Education Office of Educational Technology, 2012, p. 9)

Learning analytics "applies techniques from information science, sociology, psychology, statistics, machine learning, and data mining to analyze data collected during education administration and services, teaching, and learning. Learning analytics creates applications that directly influence educational practice" (U.S. Department of Education Office of Educational Technology, 2012, p. 9).

Affective computing is the study and development of systems and devices that can recognize, interpret, process, and simulate aspects of human affect. Emotional or physiological variables can be used to enrich the understanding and usefulness of behavioral indicators. Discrete emotions particularly relevant to reactions to challenge—such as interest, frustration, anxiety, and boredom—may be measured through analysis of facial expressions, EEG brain wave patterns, skin conductance, heart rate variability, posture, and eye-tracking.

Leveraging Data from Students' Interactions with Intelligent Tutoring Systems

Persistence and "Gaming the System"

Using EDM techniques, researchers have identified concrete behaviors in online learning environments that reflect persistence or gaming the system. Persistence in an online learning environment or a game means spending more time on difficult problems as measured by indicators such as time on unsolved problems (controlling for ability), and number of restarts and revisits to unsolved problems (Shute & Ventura, in press). Time spent on problems has been positively linked to achievement outcomes in some studies, but not always. Thus, the nature of the learning environment and kinds of questions are an important factor. In contrast to behaviors associated with persistence, when students are gaming the system, they are "attempting to succeed in an educational environment by exploiting properties of the system rather than by learning the material and trying to use that knowledge to answer correctly" (Baker et al., 2006). Gaming behavior has been shown to be detrimental to learning (Baker et al., 2004), so it is important to detect and address. Detection of gaming behavior involves looking for "sustained and/or systematic guessing" and "repeated and rapid help requests" (Baker, Corbett, Roll, & Koedinger, 2008; Baker, D'Mello, Rodrigo, & Graesser, 2010).

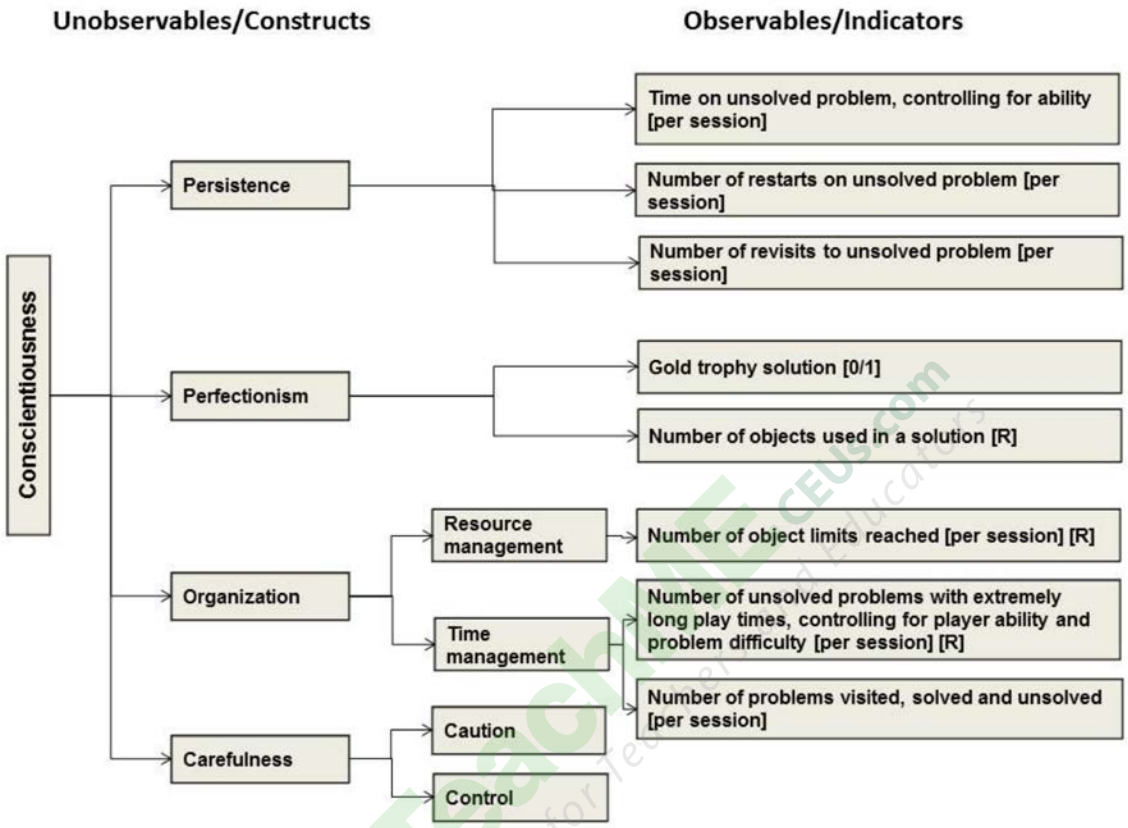
Help-Seeking Behavior

Most cognitive and intelligent tutoring systems include scaffolds and help resources and track when students use these features. Data on help-seeking can include identification of the moment when a student asked for help, the amount of help provided, the average number of hints requested per problem; how much time and effort was invested when the student asked for help; the percentage of helped problems; whether help was requested before or after making an initial attempt or after entering the correct answer (Arroyo & Woolf, 2005). In one study on the Help Tutor, an enhanced version of Geometry Cognitive Tutor, students received metacognitive feedback on their help-seeking behaviors (Roll, Aleven, McLaren, & Koedinger, 2011). For example, if a student was "drilling down" to the bottom-level hint without reading the intermediate hints, the help tutor would suggest: "No need to hurry so much. Take your time and read the hint carefully. Consider trying to solve this step without another hint. You should be able to." Students in the Help Tutor condition made fewer help seeking errors and learned more.

Some example measures. Here we describe several illustrative examples of these types of measures. The first is a set of low-tech measures that simply use wait time. The Preschool Self-Regulation Assessment includes tasks such as the "Toy Wrap," in which the child is asked not to peek while a toy is being wrapped, and the "Toy Wait," in which the child must wait before touching the wrapped toy (Murray & Kochanska, 2002). In controlled laboratory settings, these kinds of performances are easily observable. The amount of time children can delay their gratification can be used as an indicator of executive functions and effortful control.

The next set of measures includes approaches to examining students' patterns of interactions with digital learning environments. Interaction patterns can demonstrate how tool use in an environment relates to mindsets, learning goals, learning strategies, and help-seeking. Examining these interaction patterns can provide insight into the relationships between a learner's goals and behaviors. For example, many researchers are exploring how to leverage data from students' interactions with intelligent tutoring systems, such as how they may "game the system" or seek help (see callout box for more information).

Exhibit 10. A model developed by Shute and Ventura to measure indicators of conscientiousness within a digital learning environment, *Newton's Playground*



Source: Shute, V., & Ventura, M. (in press). *Measuring and supporting learning in games stealth assessment.* White paper for MIT series. MacArthur Foundation. Retrieved from http://myweb.fsu.edu/vshute/publications.html

There are several examples in other types of digital learning environments. Exhibit 10 shows Shute and Ventura's (in press) model to measure indicators of conscientiousness within a digital learning environment for physics, *Newton's Playground*. Conati and colleagues, studying behaviors in a digital math learning environment, found that learning goals associated with self-reported conscientiousness, "learning math," and "succeeding by myself" were associated with particular interaction patterns—using a "magnifying glass" to see a number's factorization, asking advice often, and following advice often (Conati & Maclaren, 2009; Zhou & Conati, 2003). Winne and colleagues examined how a suite of study tools, *gStudy* (http://www.learningkit.sfu.ca/), can provide evidence of learning strategies. The software detects when learners create notes, which information is selected by the learner to address in the note, and how the learner classifies this information on the basis of the note template selected (Winne, 2006).

Interaction patterns also can be explored by tracking eye moments to see where learners focus attention during problem solving. Conati and Merten (2007), for example, used an eye-tracking device to examine metacognitive behaviors that are relevant for learning mathematical functions. The device provided information about how learners explored the stimuli, in this case the relationship between a function's graph and equation.

Examples of affective computing methods are growing. Mcquiggan, Lee, and Lester (2007) have used data mining techniques as well as physiological response data from a biofeedback apparatus that measures blood volume, pulse, and galvanic skin response to examine student frustration in an online learning environment, *Crystal Island.* Woolf, Burleson, Arroyo, Dragon, Cooper and Picard (2009) have been detecting affective indicators within an online tutoring system *Wayang Outpost* using four sensor systems, as illustrated in Exhibit 11. Sensors provide constant, parallel streams of data and are used with data mining techniques and self-report measures to examine frustration, motivation/flow, confidence, boredom, and fatigue. The MIT Media Lab *Mood Meter* (Hernandez, Hoque, & Picard, n.d.) is a device that can be used to detect emotion (smiles) among groups. The Mood Meter includes a camera and a laptop. The camera captures facial expressions, and software on the laptop extracts geometric properties on faces (like distance between corner lips and eyes) to provide a smile intensity score. While this type of tool may not be necessary in a small class of students, it could be useful for examining emotional responses in informal learning environments for large groups, like museums.

Exhibit 11. Four parallel streams of affective sensors used while a student is engaged in *Wayang Outpost*, an online tutoring system

The field of neuroscience also offers methods for insight into some of the psychological resources associated with grit, especially effortful control. Using neuroimaging techniques, such

as fMRI, it is possible to examine which parts of the brain are active during times of anxiety or stress and the effects of some interventions. For example, Slagter, Davidson, and Lutz (2011) have investigated the effects of systematic mental training and meditation to enhance cognitive control and maintain optimal levels of arousal. Motivation was found to be associated with greater activation in multiple brain regions. Moreover, studies have reported functional and structural changes in the brain and improved performance of long-term practitioners of mindfulness and concentration meditation techniques that enhance attentional focus. These initial findings are promising evidence of the cognitive plasticity and malleability of brain functioning for processes related to grit. While it is impractical to use fMRI in the classroom (i.e., it is a prohibitively expensive, room-sized machine), Ed Dieterle and Ash Vasudeva of the Bill & Melinda Gates Foundation point out that researchers such as Jon Gabrieli and Richard Davidson are beginning to use multiple methods to explore how specific brain activity is correlated with other cognitive and affective indicators that *are* practical to measure in school settings.

Methodological tradeoffs. Measures of behavioral task performance hold strong promise for deepening the field's understanding of the interactions among the cognitive and affective processes underlying grit. They are minimally "fakable" (Kyllonen, 2005) and typically do not "cue the intentions" of the teacher or researcher (Shute & Ventura, in press). They do not require participants to have fully developed verbal skills or be able to articulate their own internal processes. Micro-level indicators also have the potential to be seamlessly integrated into a learning environment, and indicators can provide measures of behavior in real time, making it possible to examine and address dynamic changes in student understanding (e.g., how goals and affect change over time in an activity) (U.S. Department of Education Office of Educational Technology, 2013; Woolf et al., 2009).

These methods are not, however, without their own set of challenges. It is important to recognize the immense effort that goes into interpreting the meaning of student log files, for example, before an intelligent tutor can be designed to "know" what a student's behavior means and be able to offer appropriate scaffolds or feedback. The research into the design of these systems involves multiple observations and/or interviews of students interacting with the learning environment, achieving agreement among raters about how to interpret student behaviors and using these findings to design the programs that support student learning (e.g., Baker et al., 2008). Another issue with some micro-level indicators is that the approaches for gathering information can be intrusive or impractical for use in school settings. For instance, eye tracking devices can be distracting, difficult for people with heavy eyelashes or glasses, and compromised by movements from participants (Conati & Merten, 2007). Machines such as fMRI, and devices that measure EEG and skin conductance may not be practical for use in the classroom. Finally, many of these types of measures are dependent on the use of highly constrained tasks in digital learning environments, which may be difficult to translate into use in the classroom or informal learning environment.

An Evidence-Centered Design Approach to Measurement

The trade-offs and challenges above illustrate that each of the techniques and approaches for measuring perseverance and facets of mindsets, effortful control, and strategies are imperfect. In fact, assessment in any domain almost always requires making an argument about an individual's or group of individuals' knowledge, skills, abilities, or attributes using imperfect evidence. Fortunately, there are established best-practices in measurement and assessment design that can help to address the imperfections in assessment design—or at least make them explicit so that when it comes to interpreting evidence, the limitations of the evidence are transparent.

Evidence-centered design (ECD) is one approach that facilitates systematicity in design and validity of assessments (Mislevy & Haertel, 2006; Mislevy, Steinberg, & Almond, 2003). ECD has been implemented at Educational Testing Service, Cisco Systems, in state assessments for students with significant cognitive disabilities, in the National Assessment of Educational Progress (NAEP), and the Partnership for Assessment of Readiness for College and Careers (PARCC). ECD works especially well for skills, competencies, and attributes that are difficult to assess because it provides structures for laying the foundation of developing an assessment that targets the intended skills or abilities. As discussed above, Shute and Ventura (in press) used ECD to create assessments of conscientiousness, creativity, and physics competency embedded in the digital game, *Newton's Playground*.

There are always assumptions in the development of measures, and these assumptions need to be made explicit so that appropriate inferences about student performances can be made. Drawing from Messick (1994), three questions are helpful in initiating discussion about this: (1) What complex of knowledge, skills, or other attributes should be assessed? (2) What behaviors or performances should reveal those constructs? and (3) What tasks or situations should elicit those behaviors? Assessment design tools, such as *Design Patterns* and *Task Templates* (Mislevy & Haertel, 2006; U.S. Department of Education Office of Educational Technology, 2013) are helpful for responding to these questions. Exhibit 12 shows components of a design pattern with examples from Shute and Ventura and others. A task template would elaborate further task design features as well as the psychometric properties of the assessment.

Exhibit 12. Components of an ECD design pattern for measures around grit, tenacity, and perseverance

Design Pattern Attribute	Questions Assessment Developers Need to Answer	Examples
Focal Knowledge, Skills, and Abilities (Focal KSAs)	What are the core knowledge, skills and abilities are targeted?	• Behavioral perseverance • Mindsets • Effortful control • Strategies and tactics
Additional Knowledge, Skills, and Abilities	What other knowledge, skills, and abilities may affect students' ability to show what they know about the Focal KSAs?	• Knowledge of disciplinary core concepts and skills (e.g., math, science, history) • Reading and writing abilities • Ability to use technology (e.g., manipulate objects, type responses) • Prior experience or coaching on strategies to promote persistence
Observations	What does it look like when a student has a particular skill? What will they be doing?	• Working on a task for a long time • Monitoring and checking performance in relation to goals • Self-report of dispositions
Work Products	What does the student produce that will be evaluated for evidence of the FKSAs?	• Typed responses to items in a task in a technology-based learning environment • Computer log files (to be mined) • Responses to survey questions
Characteristic Features of Tasks	What are characteristics of the task or learning environment that *must* be present to elicit the Focal KSAs?	• Task must be challenging (e.g., so that students can show whether they can persevere). • If technology-based, student interactions must be logged. • Tasks must be grade-level and age appropriate.
Variable Features of Tasks	What are ways that the tasks can vary?	• Disciplinary context (e.g., math, science, history) • Task difficulty (e.g., number of steps to solve a problem) • Availability of help tutors or hints • Availability of organizational tools and supports (e.g., to highlight ideas in text, to support note taking, to arrange data) • Adaptability of learning environment to students' interests, emotions, and learning needs • Novelty of problem (e.g., new, similar to other problems played) • Relevance of learning context to student's interests

Ethical Considerations for New Types of Personal Data

As new forms of measurement emerge and new types of personal data become available, the field must also deal with critical ethical considerations. Of course, privacy is always a concern, especially when leveraging data available in the "cloud" that users may or may not be aware is being mined. However, another emergent concern is the consequences of using new types of personal data in new ways. Learners and educators have the potential to get forms of feedback about their behaviors, emotions, physiological responses, and cognitive processes that have never been available before. Measurement developers must carefully consider the impacts of releasing such data, sometimes of a sensitive nature, and incorporate feedback mechanisms that are valuable, respectful, and serve to support productive mindsets.

Moving Forward

The development of valid and reliable measures will be an important factor as we expand the capacity to design and evaluate learning environments that promote and/or teach, grit, tenacity, and perseverance. In this chapter, we explored the many purposes of such measurement and how they may contribute to these goals, and the range measurement approaches—both current and on the horizon. While there a strong foundation of work already done in this area, there are important next steps for the field. Some of the most promising new directions are educational data mining and affective computing. The method of evidence-centered design can help measurement designers build strong validity arguments as we advance measurement of these complex variables.

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Programs and Models for Learning Environments to Promote Grit, Tenacity, and Perseverance

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How can learning environments be designed to promote grit, tenacity, and perseverance? As we explored in the hypothesized model in Chapter 2, there are important *contextual factors in the learning environment* and fundamental *psychological resources within the student* that can promote these qualities. While the consensus across the literature review and interviews was that there is still a need for empirical evidence that grit, tenacity, and perseverance can be taught as transferable competencies, there is a wide range of programs and approaches that are already showing promise and positive results in this area—not necessarily by teaching "grit" directly, but through providing a supportive environment and/or opportunities to develop fundamental psychological resources.

In this chapter, we examine a wide array of approximately 50 programs across the age span and types of learning environments—formal, informal, and technology-based. Using the hypothesized model in Chapter 2 as an organizing framework, we developed five broad clusters of programs and approaches that promote grit, tenacity, and perseverance in particular ways. Note that this is not intended as an exhaustive review of all programs available, but rather a

broad overview of categories of programs and approaches being implemented and developed. We begin with an overview, mapping out this set of conceptual clusters. This is followed by brief descriptions of each cluster, using illustrative cases to highlight key points.

Overview of Clusters of Programs and Approaches

In our review of approximately 50 programs addressing grit, tenacity, and perseverance in different ways, we developed five conceptual clusters based on targeted age level, learning environment, and which facets of the hypothesized model in Chapter 2 are addressed or leveraged. Brief descriptions of the clusters are followed by a summary table in Exhibit 13.

1. **School readiness programs that address executive functions.** These are programs at the preschool and early elementary school levels that help young children develop the *effortful control* necessary for the transition into formal schooling.
2. **Interventions that address mindsets, learning strategies, and resilience.** These interventions, targeting students in late elementary school and higher, comprise the growing body of research demonstrating that relatively brief interventions can significantly impact students' mindsets, learning strategies, and academic outcomes. We also discuss programs designed to help students develop protective psychological resources for resilience in the face of difficult life circumstances.
3. **Alternative school models and school-level reform approaches.** These comprise models for the design or reform of formal school environments that are intended to teach and/or promote grit, tenacity, and perseverance.
4. **Informal learning programs.** These comprise models for informal learning environments intended to teach and/or promote some aspect of grit, tenacity, and perseverance. We focus on programs that promote (1) perseverance to graduate high school, get into college, graduate college, and enter the professional workforce; and (2) interest and persistence in STEM education and professions.
5. **Digital learning environments, online resources, and tools for teachers.** These are technology-based resources that provide contextual factors and/or opportunities to develop psychological resources that promote grit, tenacity, and perseverance.

Exhibit 13. Summary of program clusters

For each cluster, the table illustrates subcategories and a summary of the target age level(s), setting(s), aspect(s) of our hypothesized model addressed (see Chapter 2), and the type of evidence that is available about impacts on the basis of programs reviewed below. *This chapter is not intended to be an exhaustive review of all types of programs available, but rather a broad overview.*

	Age Level					Setting				Focus of Model				Evidence Available*		
Program Clusters and Subcategories	Preschool / K	Elementary School	Middle School	High School	Postsecondary	Lab-Based	Formal School	Informal Learning	Teacher PD	Effortful Control	Academic Mindsets	Learning Strategies	Contextual Factors	Noncog. Outcomes	Academic Outomes	New Programs
1. School Readiness Programs that Address Executive Functions																
Training with games	•	•				•	•			•				•		
Aerobic exercise and sports	•	•					•	•		•				•		
Martial arts and mindfulness	•	•				•	•	•		•				•		
Classroom curricula/teacher PD	•	•					•		•	•	•	•	•	•		
2. Mindsets, Learning Strategies, and Resilience																
Mindset Interventions			•	•	•	•	•		•		•		•	•		
Learning strategies Interventions			•	•	•	•	•					•	•	•		
Resiliency programs		•	•	•	•		•			•	•	•		•		
3. Alternative School / Reform Models																
Character education		•	•	•	•		•		•	•	•	•	•		•	•
Project-based learning and design thinking			•	•			•				•	•	•			•
School reform programs		•	•	•			•						•		•	•
4. Informal Learning Programs																
College-readiness and support			•	•	•			•			•	•	•			•
STEM interest and persistence		•	•	•				•			•	•	•	•	•	•
5. Digital Environments and Tools																
Provide adaptivity		•	•	•	•	•	•			•		•	•	•	•	
Provide rigorous and supportive climate		•	•	•			•		•	•	•		•			•
Provide resources		•	•	•	•		•	•	•				•			•
Provide motivating environment			•	•			•						•		•	
Promote academic mindsets			•	•			•				•			•	•	
Promote learning strategies			•	•	•		•	•				•		•		
Promote effortful control	•	•				•	•		•	•	•	•	•	•		

* Key: Evidence Available
1. Noncognitive factor as outcome: Field-Based evaluation data and/or lab-based data.
2. Primarily academic factor(s) as outcome (limited, if any, data on isolated impacts of noncognitive factors).
3. New program and/or needs further research; strong anecdotal evidence available.

Program Clusters: A Closer Look

We now take a closer look at each program cluster. For each, we examine the rationale for this type of program, targeted populations and settings, and some examples. More in-depth case studies from each category highlight key points.

1. School Readiness Programs That Address Executive Functions

At the preschool and early elementary ages, when children are transitioning to formal schooling, effortful control and executive functions have been shown to be fundamental psychological resources that are predictive of long-term success. These skills make it possible for children to satisfy expectations for self-regulation, impulse control, focusing attention, compliance with rules, and higher-order thinking that become increasingly necessary in formal schooling. Such factors have been associated with math and reading competence throughout all school years, and are likely predictors of success throughout life in career, marriage, and mental and physical health (Diamond & Lee, 2011).

As highlighted in Chapter 1, in the discussion of the challenges of underserved students in the United States, deficits in effortful control and executive functions in the early years may be a significant causal factor in achievement gaps between student populations of high poverty and their lower-poverty counterparts. High stress and a lack of opportunity to practice these skills can put high-poverty children at a significant disadvantage during the most critical years for the development of the prefrontal cortex, the part of the brain that most directly regulates executive functions. Such deficits can undermine school readiness, manifesting in both learning and behavioral difficulties that then can have a negative ripple effect throughout the rest of a child's schooling.

School readiness programs, especially those targeting high-poverty student populations and students with learning disabilities such as attention deficit and hyperactivity disorder (ADHD), have begun to focus on explicit development of executive functions. Diamond and Lee (2011) recently published a review in *Science* of evidence-based approaches for improving executive functions for children in the early school years. Approaches included the following:

- **Training with computer and noncomputer games.** Most research has focused on computerized training in which children play computer games that progressively increase demand on functions such as working memory and impulse control. Games such as *CogMed* (http://www.cogmed.com/) have demonstrated some success in these areas, though findings suggest that transfer from narrowly focused trained skills to other executive functions was limited. More research is necessary to examine the generalizability of these findings and

whether transferability may be increased with more optimal tasks, more training, or older children. Additional research has shown similar effects with noncomputer games.

- **Aerobic exercise and sports.** There is some evidence to show that aerobic exercise can improve prefrontal cortex function and executive function. Most of the findings are with adults, but some are with children. Research is still necessary to determine how much exercise is needed, when it is most beneficial, what its specific cognitive impacts are, and for whom it is most effective.
- **Martial arts and mindfulness practices.** An increasing number of studies suggest that martial arts, which traditionally emphasize self-control and character development, can significantly improve executive functions for 5- to 11-year-olds. Mindfulness training, emphasizing regulating attention to focus in a nonjudgmental way on experiences in the present moment, can significantly improve executive functions. There is some evidence that yoga may also have potential to increase these skills.
- **Classroom curricula and teacher professional development.** Several programs for preschool and elementary school children have demonstrated effectiveness in impacting executive functions. *Tools of the Mind* (http://www.toolsofthemind.org/) is a curriculum for preschool and kindergarten based on Vygotskian principles, emphasizing the importance of pretend play (see callout box below). *Montessori* (http://www.amshq.org/) is a school model that emphasizes self-discipline, independence, orderliness, and peacefulness. A randomized controlled trial showed that Montessori children showed better executive functions than peers attending a different school. *PATHS* (Promoting Alternative Thinking Strategies) (http://www.pathstraining.com/) is a teacher professional development program to train teachers to build children's competencies in self-control, emotion regulation, and interpersonal skills. Teachers are provided strategies to help children deal with their emotions when they are upset by stopping, taking a deep breath, articulating how they feel, and constructing an action plan. The *Chicago School Readiness Project* (CSRP) (http://steinhardt.nyu.edu/ihdsc/csrp/), another teacher professional development program, provides Head Start teachers with extensive behavioral management training and strategies for reducing their own stress. CSRP classrooms, compared to controls, provide more emotionally supportive classrooms and improved executive functions.

Diamond and Lee (2011) conclude their review with a summary of findings and recommendations for practice and future research for improving executive functions (EFs). The general summary is as follows:

> Stress, loneliness and not being physically fit impair prefrontal cortex function and EFs. The best approaches to improving EFs and school outcomes will probably be those that (a) engage students' passionate interests, bringing them joy and pride, (b) address stresses in students' lives, attempting to resolve external causes and strengthen calmer, healthier

responses, (c) have students vigorously exercise, and (d) give students a sense of belonging and social acceptance, in addition to giving students opportunities to repeatedly practice EFs at progressively more-advanced levels. The most effective way to improve EFs and academic achievement is probably not to focus narrowly on those alone, but to also address children's emotional and social development (as do all 4 curricular-based programs that improve EFs) and children's physical development (aerobics, martial arts, and yoga) (p. 7).

Tools of the Mind

Tools of the Mind (http://www.toolsofthemind.org/) was created in 1993 to train teachers to help preschool students develop self-regulation and executive functions using techniques developed by Lev Vygotsky (e.g., Vygotsky,1978). Together, self-regulation and executive functions are responsible for a students' ability to control their thinking and behavior, with strong connections to working memory, impulse control, problem solving, and mental flexibility (Chan, Shum, Toulopoulou, & Chen, 2008). Ages 3 to 7 are critical for the development of those abilities and the parts of the brain that control them (Diamond & Lee, 2011).

Leaders of Tools of the Mind (often called *Tools*) believe that learning and early development is best accomplished through play and sustained attention, especially when it is social and students construct information for themselves. The pedagogical strategies employed are aimed at sustaining attention and persevering in challenging activities. One key pedagogy is dramatic play, which involves planning, sustained attention, and multiple roles for different students. Pretend roles give students rules, often self-created, that they need to apply to their actions. This process is an abstract cognitive task that resembles much of the intellectual work that school entails, such as remembering the rules to capitalize when starting a sentence or to raise a hand instead of blurting something out. Yet, the play and imaginary aspects make this form of practice more engaging. The use of symbols is another Tools technique that develops abstract thinking. These symbols, an integral part of dramatic play, are classroom objects that become entirely different apparatuses in the student mind, involving abstract and flexible thinking. Other strategies are self-regulating private speech, which helps students visualize, plan, and strategize, and specific external aids for attention and memory (e.g., pictures representing actions to serve as scaffolds).

In 2007, Tools was examined in a randomized controlled trial with 85 Tools students and 62 students participating in the urban district's balanced literacy program. Classrooms using the Tools model showed relatively higher improvement on executive functions and inhibitory control, displayed on tasks demanding those capacities (Diamond, Barnett, Thomas, & Munro, 2007). Today, the Tools of the Mind curriculum and professional development are in 18,000 pre-K and kindergarten classrooms across the country.

2. Interventions That Address Mindsets, Learning Strategies, and Resilience

Academic mindsets and learning strategies are another essential set of psychological resources for grit, tenacity, and perseverance. Researchers have been producing significant academic and psychological impacts using short-term mindset interventions that affirm who students are and want to be, mitigate threats to self-esteem, and teach students that ability grows with effort. Interventions are also helping young people develop important strategies so that they can set meaningful goals, make plans to accomplish these goals, rehearse responses to potential

problems, manage time, monitor progress, and change course when necessary. Recent reports released by the Stupski Foundation (Snipes et al., 2012) and written by Yeager & Walton (2011) provide reviews of interventions that target mindsets and strategies, and their available evidence to date. We also discuss interventions that provide children and adults with robust toolkits of strategies for solving problems and coping with difficult situations and emotions—key protective psychological factors that support resilience in the face of challenging circumstances.

Academic mindsets. Over the last several years, there has been a movement in social psychology to use empirically based theoretical principles to design short and focused interventions (e.g., 2 to 10 hours) that target specific academic mindsets. Early evidence based on experimentation in school settings suggests that these interventions have the potential for powerful impacts on the psychological resources that can directly affect perseverance, as well as academic achievement. Snipes and colleagues (2012) review several types of mindset interventions:

- **Teaching students the "growth mindset."** These interventions address the mindset, "My ability and competence grow with my effort." The "growth mindset" is perhaps the most fundamental to grit, tenacity, and perseverance in academic pursuits, as it has been found that students are more likely to persist through academic challenges when they believe the effort will make them smarter and lead to success. Snipes and colleagues reviewed four interventions that address this mindset. Three interventions targeted middle school students and showed positive impacts on academic achievement. In each one, students were explicitly taught that intelligence is malleable and that the brain can grow like a muscle with effort. Training was in several different modalities: a workshop (Blackwell et al., 2007), the interactive software *Brainology* (Paunesku, Goldman, & Dweck, n.d.) (see more detail below), and a mentoring program (Good, Aronson, & Inzlicht, 2003). An intervention for college students was delivered in the form of a pen pal activity (Aronson, Fried, & Good, 2002).

  More generally, in our interview with Stanford University Psychologist Carol Dweck, she emphasized that a fundamental practice for teachers and parents is to praise students for *effort* they put into academic tasks, not for their ability.

- **Shifting students' explanations for academic and social challenges from personal failure to temporary external factors.** With the intention of stopping a common negative cycle of self-blame and doubt that can undermine persistence, these interventions are intended to help students learn to attribute challenge to external factors that are "bumps in the road" rather than to personal failure or lack of belonging in a rigorous academic community. These interventions address the mindsets, "I can succeed at this," "Challenge is inevitable for success," and "I belong in this academic community." Snipes and colleagues discuss three interventions, all for college age students. One intervention, using video and school records, was intended to shift freshmens' mindset about setbacks and challenges so that they

attributed them to common experiences in the transition from high school to college, not to their own personal failure (Wilson & Linville, 1985). A second intervention had minority students make speeches that would ostensibly be delivered to future freshmen to instill the notion that challenges may be attributable not to personal failure but a common experience that minorities often feel like they do not belong in the academic community (Walton & Cohen, 2007). A third intervention showed that students' persistence was greater in the face of critical feedback when it was delivered with a message that the student was being held to high standards (Cohen, Steele, & Ross, 1999).

- **Affirmation of personal values.** These interventions address for ethnic minority students the stress they may encounter from stereotype threat, a threat to self-esteem that entails a felt pressure and anxiety that his or her poor performance may confirm a negative stereotype about their ethnic group (see callout box in Chapter 1). The interventions focus on bolstering the mindsets, "I can succeed at this," and "I belong in this academic community." In one study, middle school ethnic minority students were provided the opportunity to write a "values essay," in which they spent 15 minutes writing about a value that was important to them, such as a hobby or relationships with friends. Compared to control students, these students had increased grade point averages. The authors suggest that this intervention functions by mitigating the distracting anxiety of stereotype threat through affirmation of the self as an individual with strong values (Cohen, Garcia, Apfel, & Master, 2006).
- **Relating course material to students' lives.** One research-based intervention was designed to address the mindset, "This work is in line with my interests, values, or goals." In this study, high school students were asked to write essays connecting what they were learning in science class to their own lives. This intervention increased interest in science and course grades for students who initially reported that they did not expect to do well in science (Hullemen & Harackiewicz, 2009).
- **The "Super Intervention.**" Snipes and colleagues (2012) note that in work funded by the Raikes Foundation, Cohen, Dweck, and Walton are currently working on what they call a "Super Intervention" that integrates a set of these interventions at the same time. The logic is that different interventions may be more effective for different students, so it is important to provide multiple opportunities. Initial research began on this approach in Fall 2012.

Learning strategies and tactics. Snipes and colleagues (2012), and Yeager and Walton (2011) also reviewed several interventions that provide students with strategies for how to deal with challenges and setbacks, and to improve metacognition and/or self-regulation.

- **Investment in clarifying goals and anticipating potential obstacles and solutions.** Since grit, tenacity, and perseverance are by definition about achieving goals in the face of challenges and setbacks, one approach is to make sure students are clear about what their goals are, why they are important to them, and what they will do when they face challenges. Three examples follow.

- *Mental contrasting/implementation intentions (MCII).* Duckworth and colleagues (2011) demonstrated how a strategy they call "mental contrasting/implementation intentions" (MCII) improved high school students' persistence in studying for the PSAT. Mental contrasting refers to contrasting the idea of a desired future with possible obstacles. In a randomized experiment, MCII students received a PSAT workbook and were asked to write about positive outcomes of finishing the practice tests, two obstacles that could prevent them from doing so, and two plans to overcome each of the two obstacles they had identified. Compared to control students who received the same workbook but did not do the mental contrasting exercise, MCII students completed substantially more of the workbook during their summer vacation.
- *Possible Selves exercise.* In Osterman and colleagues' (2006) "Possible Selves" workshops, middle school students went through a series of workshops in which they imagined themselves as adults and the positive possible selves they could become. They also imagined the positive and negative forces that would help or hinder their progress, timelines for achieving their goals, actions and strategies for achieving their goals, and problem-solving strategies for dealing with obstacles. In a randomized experiment, 2 years after this intervention, students had higher tests scores and GPAs, fewer incidents of disruptive behavior, and more positive mental health.
- *Online goal-setting program.* Morisano and colleagues (2010) reported on *Self Authoring* (http://www.selfauthoring.com/), a web-based program for struggling college students that provided eight steps for having students elaborate on their desired futures, specific goals related to those futures, plans for achieving them, and commitment to achieving them. In a randomized experiment, students who used this program had higher GPAs, higher levels of credit accumulation, and more positive emotions and beliefs.

- **Developing general study skills to deal with cognitive demands.** Students may fail to persist when academic material gets challenging because they do not have appropriate skills to deal with cognitive demands. Jairam and Kiewra (2009) demonstrated that an intervention called "*SOAR*" bolstered college students' test scores. The acronym SOAR stands for four different types of strategies around note-taking ("selection"), using graphic organizers ("organization"), building new knowledge from what they know ("association"), and testing their mastery of new material ("regulation").
- **Building a robust set of structures for success.** Another program example provides students in grades 5 to 10 with cognitive, social, and self-management skills. In the *Student Success Skills* (http://www.studentsuccessskills.com/) program (Brigman & Webb, 2007) students work in groups to improve goal-setting, progress monitoring, building a supportive social community, cognitive and memory skills, dealing with pressure and anxiety, and building healthy optimism. This program has been shown to increase reading and math achievement.

- **Developing content-specific metacognitive skills.** Students also need to develop content-specific metacognitive skills for planning and monitoring to deal with disciplinary-specific challenges. Snipes and colleagues discuss two such interventions. *Thinkertools Inquiry Curriculum* (http://thinkertools.org/) helps students in grades 7 to 9 learn to monitor and reflect on their progress as they conduct inquiry science projects (White & Frederiksen, 2001). *Reading Apprenticeship* (http://www.wested.org/cs/ra/print/docs/ra/home.htm) helps students learn metacognitive skills for reading and analyzing texts in specific disciplines, through conversations with teachers about their own mental processes, strategies, knowledge resources, motivations, and affective responses to texts. Greenleaf et al. (2011) showed that Reading Apprenticeship significantly impacted high school biology students' achievement on tests in English language arts, reading comprehension, and biology.

These mindset and strategy interventions point to powerful new opportunities to help students develop the psychological resources to persevere in the face of a variety of types of challenges and setbacks. These interventions target a range of age levels, from middle school through college. Many target underserved student populations or other types of struggling students. The callout box on the next page describes additional programs that support the development of protective factors for children and adults that support resilience in the face of life challenges. These approaches combine attention to mindsets and strategies with other social-emotional competencies.

Research is still necessary to develop and match particular types of interventions to specific needs, to help educators integrate these interventions into their practice, and to examine impacts at scale in a variety of settings and across age levels.

3. Alternative School Models and School-Level Reform Approaches

Another set of approaches promote grit, tenacity, and perseverance through alternative school models or reform efforts at the school level. Programs target schools at all levels of the socioeconomic spectrum, in public charter schools, traditional public schools, and private schools. Depending on the approach, these noncognitive factors may be addressed directly and explicitly, or more implicitly integrated in a comprehensive educational model.

What each of these approaches has in common is a mission to change in fundamental ways how schools prepare a wide diversity of students to build deep understanding and critical skills for the 21st century. For example, charter school networks, like KIPP, Envision, and Mastery, were founded between 1994 and 2001 with specific missions to raise achievement for disadvantaged student populations. Despite their positive mission and clear evidence of shrinking the K-12 achievement gap, leaders discovered that achievement gains alone were not leading to higher college graduation rates. Leaders were also learning, anecdotally, that the students who were able

to get into college and graduate successfully were not necessarily the most intellectually talented, but the ones who developed grit and positive academic mindsets. At the same time, leaders in schools with much more diverse student bodies had been coming to recognize that all students benefit from an education that encourages students to strive, not fear failure, and persist, and that persistence is more likely in learning environments that are intentionally designed to promote it. Some school reform efforts have sought to restructure the organization and climate of schools to provide students with a more supportive learning environment.

Programs to Develop Resilience in Children and Adults

Penn Resilience Program (PRP)

The *Penn Resiliency Program* (http://www.ppc.sas.upenn.edu/prpsum.htm) is a group intervention designed to teach upper elementary and middle school students to cope with challenging emotions and difficult situations. Based in part on cognitive-behavioral theories of depression, PRP uses several evidence-based factors to improve resilience, including self-awareness and identifying counterproductive thoughts. Students learn assertiveness, self-regulation and how to challenge negative beliefs. PRP is typically delivered in 12 90-minute lessons or in 18-24 60-minute lessons by trained leaders with expertise in psychology, education, or mental health. Students learn resilience concepts in each lesson through skits, role plays, short stories, and cartoons and are encouraged to apply these skills in their lives as part of their homework each week. Nineteen controlled studies have evaluated the efficacy of PRP, and a meta-analysis of these studies demonstrated that PRP participants had fewer symptoms of depression than participants in no-intervention control conditions for up to 24 months.

United States Army Master Resilience Trainer (MRT) Course

As described in Reivich, Seligman, & McBride (2011), the U.S. Army *Master Resilience Trainer Course* (http://www.jackson.army.mil/sites/vu/pages/273) is a 10-day program designed to teach resilience skills to noncommissioned officers (NCOs), who then will teach these skills to their soldiers. MRT focuses on preventing post-traumatic stress syndrome and incorporates key elements from the PRP and from a parallel program called APEX that addresses depression and anxiety in college students (Gillham, Jaycox, Reivich, Hollon, Freeman, DeRubeis, & Seligman, 1991; Reivich, Shatté, & Gillham, 2003). The first eight days are organized into four modules. Module 1 explores factors that contribute to resilience and introduces the core competencies of resilience targeted by the program. Module 2 builds mental toughness by helping soldiers learn to distinguish between activating events and the thoughts, emotions and consequences that follow. They learn patterns of thinking that lead to adaptive outcomes and resilience and strategies for challenging counterproductive beliefs. In Module 3, soldiers complete an online character strengths questionnaire (http://www.authentichappiness.org) that rank orders and define strengths. They practice using individual and team strengths to meet goals and overcome challenges. Module 4 focuses on strengthening relationships among soldiers and among soldiers and their families through the application of constructive responding, praise, and communication style. The *sustainment component* on Day 9 addresses the application of these skills in a military context, sustaining resilience, and determining when an individual is struggling with resilience. During the *enhancement component* on Day 10, soldiers learn to identify connections between thoughts, emotions, physiological states, and performance; effective ways to create enthusiasm and optimism; how to articulate actionable plans to attain goals; strategies for attention control in demanding situations; strategies for maintaining optimum energy; and how to use mental imagery techniques to create or recreate successful experiences. Initial evaluations of the program from NCOs have been positive.

Here we discuss three approaches. Note that our analysis is based on a limited dataset; the analysis should not be considered an exhaustive categorization.

Character education models. These models began in the last 5 years with collaboration among Principal Dominic Randolph of the New York City private school *Riverdale Country School* (http://www.riverdale.edu/), David Levin of the *KIPP Charter Network* (http://www.kipp.org/), and psychologists Martin Seligman, Chris Peterson, and Angela Duckworth (see callout box below for more detail on KIPP). They began with the vision of using principles from Positive Psychology—the science of positive human functioning—to develop a model of schooling that would help students learn how to develop grit as a transferable competency and persist to get into college and graduate. The models have evolved to target both the contextual supports and psychological resources that facilitate grit, tenacity, and perseverance. As we learned in our interview with journalist Paul Tough, who has written extensively about these schools, key features of the model include explicit articulation of learning goals for targeted competencies, clear and regular assessment and feedback of student progress on these competencies (i.e., using the Character Report Card, shown in Exhibit 9 in Chapter 3), intensive professional development to help teachers understand and work with these competencies, and discourse about these competencies infused throughout the school culture and all disciplinary curricula. This model is emerging in other schools as well, such as the *Mastery Charter Network* (http://www.masterycharter.org/), and it has become a focus of teacher professional development in the *Relay Graduate School of Education* (http://www.relay.edu/) in New York City.

At the college level, one university has been developing a model of character education—California's Azusa Pacific and its *Noel Academy for Strengths-Based Leadership and Education* (http://www.apu.edu/strengthsacademy/). The Noel Academy acts as a student resource by helping students determine their character strengths and how to conscientiously utilize them with the assignments they take on in class. It also provides teacher professional development to help instructors design learning sequences that take student strengths and interests into consideration, along with ample opportunity to help students reflect on how they might apply their character strengths to learning tasks.

While there is powerful anecdotal evidence for the impacts of character education models, there is still a need for rigorous investigation of transferability of competencies, impacts on learning, and implications for scaling to other settings.

KIPP (Knowledge is Power Program)

KIPP started as a middle school model in low-income communities developed by Teach for America alumni Mike Feinberg and Dave Levin. After establishing many successful middle schools, they eventually expanded to elementary and high schools as well. Overall, their students are 59% African American and 36% Latino/Hispanic; 87% receive free or reduced-price meals.

KIPP made national news in 1999 when KIPP Academy middle school's first graduating eighth-graders had the five highest test scores in all of New York City. However, years later, data on the students graduating from KIPP middle schools would reveal that many struggled academically in non-KIPP high schools and college. According to their website, "As of fall 2011, 36 percent of KIPP students who completed eighth grade at KIPP ten or more years ago have graduated from a four-year college." Their high rate of student entry into 4-year colleges (84%) and low rate of college graduation (36%) spurred KIPP leadership to evaluate what was missing in their schools. They began to hypothesize that their alumni who succeeded could be characterized as having the intangible skills consistent with important noncognitive factors. KIPP then became strongly influenced by the work of Positive Psychology researchers, such as Duckworth and Seligman, as the field was beginning to show that long-term success was just as contingent on noncognitive abilities as intellectual abilities.

For the last several years, KIPP has been developing and implementing a character education model to foster key noncognitive abilities, with a particular emphasis on grit. They teach these qualities as skills that can be worked on and improved, and strive to create school-wide discourse around character. They emphasize many of the contextual factors and psychological resources in our model. For example, KIPP focuses heavily on goal-setting as a key motivating factor. Mitch Brenner, KIPP New York's administrative lead on character development, runs teacher professional development focused on goal-setting, with a special emphasis on giving students agency in creating their own goals. Importantly, KIPP also provides critical supports for students' striving to achieve their goals. For example, around mindsets, Carol Dweck's "growth mindset" has been taught in KIPP schools for many years, and its messaging resembles the way that KIPP educators talk to students about the malleability of their character skills. Effortful control skills are taught as part of a weekly character class, through dual-purpose lessons with both academic and character objectives, and reinforced by public reminders. For example, students walk around school wearing shirts that read, "Don't eat the marshmallow," a reference to the classic self-control study in which children needed to abstain from eating a marshmallow in order to earn a reward (which we discuss in Chapter 2 in the section on Effortful Control). The Character Report Cards (see Chapter 3 for an example) are used as formative assessments to help students gauge and work on their own progress with the noncognitive factors.

Evaluation data are not yet available about growth of noncognitive factors. However, data on achievement has been strong and positive. A study by Mathematica in 2010 matched KIPP students with similar peers at local schools and measured their achievement longitudinally. The study found that students attending a KIPP middle school had higher math achievement by .48 standard deviations, the equivalent of 1.2 years of learning or half the black/white achievement gap. The study also found reading achievement in KIPP schools was higher by .28 standard deviations, the equivalent of .9 years of learning and a third of the black/white achievement gap.

Project-based learning and design thinking models. These models include schools with intensive focus on learning strategies for accomplishing long-term goals and an emphasis on feedback and iteration. In *project-based learning* (PBL), students take on real-world problems in any discipline and develop long-term projects around these problems. Connections to the real world provide a motivating context, and long-term projects provide opportunities to develop 21st-century skills such as problem-solving, collaboration, researching, and communication. In particular, students learn important learning strategies and self-regulation skills necessary for perseverance over the long term to achieve the goals of a given project. They may learn skills

such as task definition, planning, monitoring, deliberation over findings, and adaptation of approach. *Design thinking* is a pedagogical paradigm that emphasizes the processes necessary for innovative design—brain storming, using imagination, collaboration, prototyping, feedback, and iterative development (Carroll et al., 2010). Design thinking supports perseverance through the development of important mindsets and learning strategies, as students learn to "fail early and often" and use feedback to iteratively improve a product.

Some schools are beginning to implement PBL with the intention of fostering grit, tenacity, and perseverance, among other competencies. One such school is *Envision Charter School* (http://www.envisionschools.org/) in San Francisco. This school serves a diverse student population (78% black and Latino, 60% first-generation college bound, and 61% qualifying for free or reduced-price lunch). A key foundation of the charter is PBL, culminating in a college success portfolio produced during the senior year. Envision, from its inception, saw the pursuit of long-term goals and all the necessary skills that demands as the most critical elements of learning. Time-management and persistence through long-term projects are central in their model. While formal evaluation data is not yet available, Envision reports that 98% of their graduates go to college and 91% remain in college.

Quest to Learn (http://q2l.org/) is a network of two schools in Chicago and New York City that share much of the same philosophy, placing a strong emphasis on design thinking. Founded on principles of game design, the activities in these schools utilize the motivating qualities of game play to encourage creativity and deep cognitive engagement. What aligns their philosophy closely with PBL is their view that the best learning happens through a process of trying, failing, and iterating. In fact, there is an expectation at these schools that assignments almost never be turned in just once. The process of getting feedback, from both teachers and peers, before persisting in creative ways to improve one's work, is seen as a critical in learning and developing as a student.

Beyond these models, there are a number of schools throughout the country that are developing their own models. The *Middleshift Initiative*, funded by the Raikes Foundation, has begun to build a resource network of such programs to foster what they call "agency"—a combination of productive mindsets and learning strategies. Middleshift convened a conference in fall of 2012 in which practitioners, researchers, and policymakers met to begin to build a community of practice and explore essential design principles.

These models have just begun to emerge in last 5 years or so, and touch only a small percentage of schools throughout the country. More research is necessary to refine the models and establish whether they are effective, for whom, and under what circumstances.

School reform programs. A third approach is found in reform programs that work with schools to help them set up learning environments that are supportive of perseverance. Darling-

Hammond (2002) discusses ten principles for redesigning high schools with a "small school" model that works. These principles can also be used to design smaller learning communities within larger schools. The principles include (1) personalization of instruction, (2) continuous relationships with teachers over time, (3) high standards and performance-based assessment, (4) authentic curriculum that focuses on deep understanding and connections to students' lives, (5) pedagogy adapted to individual learning needs, (6) multicultural and anti-racist teaching to support belonging for all students in the school community, (7) knowledgeable and skilled teachers, (8) opportunities for teachers for collaborative planning and professional development, (9) connections to the family and community, and (10) democratic decisionmaking such that all stakeholders have a voice in governance.

We reviewed some highly regarded organizations whose missions are to support schools in enacting many of these types of design principles in their structure and culture:

- *Coalition of Essential Schools* (http://essentialschools.org/). This program, based in Rhode Island, works with educators, districts, and other entities throughout the country using a guiding philosophy to create "personalized, equitable, and academically challenging schools for all young people." They facilitate communication among the hundreds of schools in their network, provide professional development and community building, provide informational resources for educators about best practices, and advocate for appropriate resources and conditions at the local, state, and national levels.
- *Turnaround* (http://turnaroundusa.org/). This program works with high-poverty schools in New York City and Washington, D.C., to create school environments that help students overcome obstacles presented by poverty for students' learning and development. They provide training and support for teachers in research-based, high-leverage instructional practices (e.g., formative assessment, cooperative learning) and classroom management practices that promote a positive school climate, targeted behavioral and academic interventions for high-need students, and other support necessary for schoolwide improvement
- The *Small Schools Workshop* (http://smallschoolsworkshop.wordpress.com/). Based in Chicago, this is a consulting firm that "helps schools and school districts strategize to create smaller, personalized and effective learning communities." It works directly with schools and districts, providing professional development and organizational supports for school improvement.
- *Compassionate Schools Initiative* (http://www.k12.wa.us/CompassionateSchools). This program, located in the state of Washington, focuses on developing school climates and social-emotional competencies that support resilience, particularly among communities exposed to chronic stress and trauma (though it is open to any school seeking training to encourage compassionate classrooms and attitudes among school staff). The program trains

and supports school staff to establish a culture and climate with a strength-based approach that encourages open communication, voice and ownership for all members of the community, flexible accommodations for diverse learners and vulnerable students, compassionate and effective discipline strategies, and strategies for continuous quality improvement.

4. Informal Learning Programs

Learning in its broadest sense takes place in every activity of life, inside and outside of school. According to Lemke, Lecusay, Cole, & Michalchik (2012):

> [*Informal learning* refers specifically to participation in] organized activities in face-to-face or online settings (or both) other than formal instruction, in which a number of the following features are especially relevant or salient: voluntary participation, relatively equitable power relations in negotiating goals and means, enjoyment of the learning activity for its own sake, intense engagement with tasks, flexibility of goals and in re-purposing resources, unpredictability of some significant learning outcomes, improvisation and innovation within and concerning the activity, commitment over time in the face of obstacles. (p. 13)

Informal learning that happens in out-of-school settings is usually a group context, where students go on cultural field trips, meet in institutional environments during off-hours, or mingle with working professionals. They can often have rich technology components. Programs focus on students from elementary school through college, but most focus on the older students.

Indeed, there is great potential for informal learning environments to provide essential contextual factors to promote grit, tenacity, and perseverance. While there are many different types of informal learning programs, here we explore two categories of programs intended to promote grit in different ways. We provide well-regarded examples of each.

- **Out-of-school support systems to help students persist through high school, get into college, and enter the professional workforce.** Many programs focus on promoting ambitions to go to college and obtain a job, and provide a social network of peers and/or mentors who guide the students through the transitions to high school, college, and career. Program providers often emphasize that their services address a gap in the students' home settings, where students may be among the first in their families to go to college. Some examples are as follows.
  - *The Breakthrough Collaborative* (http://www.breakthroughcollaborative.org/). This program begins working with students in a 6-week program in the summer of their seventh-grade year to introduce them to long-term planning for attending college. They

receive year-round support and tutoring and structured college preparation activities as they move through a college preparatory high school program. Breakthrough emphasizes long-term and multi-dimensional support, from the academic to the social.

- *College Track* (http://www.collegetrack.org/main/). This program engages students from the summer before they start high school through the next 8 years to support their goals of going to college and graduating. They focus on students who are the first in their families to earn a college degree. The program complements high school tutoring and college application and support programs with a Student Life program that engages them in service learning, arts, leadership opportunities, and cultural trips.
- *KIPP Through College* (http://www.kipp.org/ktc). The KIPP secondary program has expanded to provide a set of academic and organizational supports to support college planning, application, and success. These services are offered beginning in middle school and extend through college. The offerings vary by region—Austin, Houston, New York, Los Angeles, the San Francisco Bay Area, and Washington, D.C. Graduates participate in activities such as weekly or annual alumni events, as-needed support around college or job applications, out-of-school job exploration programs, and tutoring.
- *OneGoal* (http://www.onegoalgraduation.org/). This program calls itself a "college persistence program," and the one goal is college graduation. Led by teachers, the program emphasizes social support with structured planning to address challenges around college application and initial college adjustment. OneGoal offers a conference to high school juniors to introduce them to college preparatory activities, help in planning the college and financial aid application process, campus visits, social support from a peer network, online support and planning activities before students begin their freshman year in college, and a reunion during the first winter break of freshman year. Eventually, successful OneGoal "fellows" offer social support to younger students in the program.
- *Student Success Academy* (http://www.studentsuccessacademy.com). This is an online interactive program that pairs a high school student with a "personal success consultant," a highly successful college student mentor, who can help the high school student navigate through the process of getting into college. The program also includes internship opportunities and a curriculum to help students identify their interests and take actions toward finding and building a satisfying career.

- **Out-of-school programs intended to trigger interest and persistence in STEM pathways.** Many programs are intended to engage the interest and enthusiasm that, over the long term, could promote persistence in STEM studies through to a STEM professional career. Some of the programs are also intended to simply instill academic mindsets that support perseverance in general. Some examples are as follows.

- *Galileo Learning Science Camps* (http://www.galileo-learning.com/). This camp offers week-long summer sessions that inspire exploration of science, art, and history. See callout box.

- *Girls Inc* (http://www.girlsinc.org/). This is a national network of affiliates that provides out-of-school programming for girls K-12 who are primarily from low SES and underrepresented populations. It encourages all girls to be strong, smart, and bold. Girls Inc. programs address the "whole girl"—personal, interpersonal, academic, health, and fitness. The program *Operation SMART* develops girls' enthusiasm for and skills in science, technology, engineering, and mathematics. Through hands-on activities, girls explore, ask questions, persist, and solve problems. They also interact with women and men pursuing STEM careers, helping girls to come to view these careers as exciting and realistic options for themselves. The STEM programs, *Build IT* and *InnovaTE^3* were also designed to encourage girls' persistence in STEM learning and career pursuits.

- *Project Exploration* (http://www.projectexploration.org/). This is a nonprofit science education organization that works to ensure that communities traditionally overlooked by science—particularly minority youth and girls—have access to personalized experiences with science and scientists. Project Exploration targets students who are open-minded and curious, regardless of academic or economic standing, and gives them the opportunity to explore a variety of scientific disciplines alongside scientists in the workforce. Project Exploration students are more likely to graduate high school, go to college, and major in science than their peers: over 96% of Project Exploration fieldwork participants graduate from high school. These students are three times more likely to enroll in a 4-year college than their peers, and over one third of alumni major in science in college. Participants attributed their persistence to participation in these programs (Chi, Snow, Goldstein, Lee, & Chung, 2010).

Galileo Learning Science Camps

At Galileo Learning summer camps (http://www.galileo-learning.com/), students use materials, tools and technologies to create, test, and share their ideas about science, developing mindsets that promote perseverance. The Galileo Innovation Approach emphasizes an "innovation mindset," which includes five elements: (1) Be Visionary (e.g., "I imagine things that don't yet exist"); (2) Be Courageous (e.g., "I embrace challenges"); (3) Be Collaborative (e.g., "I value the unique perspectives of others"); (4) Be Determined (e.g., "I persevere until I achieve my goal"); and (5) Be Reflective (e.g., "I take time to think about what is and isn't working in my design"). Camp Galileo offers week-long sessions around an imaginative story or theme that inspires exploration of science, art, and history. For example, during one week about the art and science of music, students engineered instruments and created sculptures modeled on Picasso's deconstructed instruments or mixed media collages inspired by artist Romare Bearden. The program for middle school students incorporates technologies in activities such as digital photography, filmmaking, video game design, and LEGO robotics. Galileo Camps were established in 2002 and are available in the San Francisco Bay Area for rising kindergarteners to eighth graders.

5. Digital Learning Environments, Online Resources, and Tools for Teachers

There is a large and growing array of educational technologies that can be used to support grit, tenacity, and perseverance. A core recommendation from the experts we interviewed was that technology to support perseverance should be grounded in design principles aligned with the general best practices for fostering these competencies. In fact, we found educational technologies aligned with all aspects of our hypothesized model of grit, tenacity, and perseverance—promoting both important contextual factors and psychological resources.

Here we present some examples from a range of categories aligned with key facets of the model. Note that many of these fit in more than one category or categories previously discussed.

- **Digital learning environments that provide optimal challenge through adaptivity.** While students differ in their learning needs and their responses to learning activities, in a typical class, teachers have too many students to provide a high level of individualized support. As discussed in Chapter 3, digital learning environments provide great potential for collecting complex, "micro-level" data about behavioral task performance, affective responses, and physiological responses that can be used dynamically within a system or provided to teachers to adapt instructional tasks to learner needs. Intelligent tutors such as *Cognitive Tutor* (http://www.carnegielearning.com/), *ASSISTments* (http://www.assistments.org/), and *Wayang Outpost* (http://wayangoutpost.com/) are examples of digital learning environments that can analyze students' responses to questions and provide adaptive tutoring and practice activities adapted to individual students' needs. Technologies such as Wayang Outpost are beginning to employ affective computing, using inputs from physiological indicators and facial expressions to collect and utilize data indicating affective states such as frustration and boredom (see callout box). *Reasoning Mind* (http://www.reasoningmind.org/) is a digital math curriculum for elementary school students that has multiple mechanisms of assessment and adaptation. The system itself can adapt to students' learning needs by providing more remedial or more advanced problems as needed. It also provides immediate feedback to the teacher, making specific recommendations for small group interventions in complement to online learning. Other online learning platforms,

Wayang Outpost

Wayang Outpost is an intelligent tutor designed to prepare middle school and high school students for geometry and statistics on standardized tests. The system customizes problems and hints to each student's cognitive profile and emotional state (e.g., frustration or boredom) using inputs from physiological indicators and facial expressions. Measurement tools are discussed in Chapter 3 and shown in Exhibit 11. Animated "agents" then respond to the student, for example by sharing some worked out problems if the student is frustrated or by praising effort if the student completed a problem (Woolf et al., 2009). Researchers at the University of Massachusetts are currently evaluating whether affective agents perceived as caring can increase the likelihood that students will persist through frustrating portions of instruction and exhibit greater mastery of content.

such as *Knewton* (http://www.knewton.com/) and *Agilix* (http://agilix.com/) (see callout box) are implementing personalized learning models.

- **Digital tools to help educators promote a rigorous and supportive classroom climate.** There are several new and emerging digital tools intended to help teachers promote positive classroom cultures and support perseverance in their classrooms. *ClassDojo* (http://www.classdojo.com/) is a classroom management tool that helps teachers maintain a supportive learning environment and keep students persisting on task in the classroom. Through a system with engaging and personalizable animation, features allow teachers to track and reinforce good behaviors for individual students, and get instant reports to share with parents or administrators. *Kickboard* (http://kickboardforteachers.com/) is an online tool that helps teachers and schools track and report on grades and behavior in real time. In one central repository, teachers can keep a variety of types of data on individual students, including updates on positive behaviors and discipline problems throughout the day, that can be shared instantaneously with all teachers and administrators in the school. One feature is that teachers can "analyze classroom and school culture" by plotting these factors over time. *SimSchool* (http://www.simschool.org/) is a platform used for preservice teacher professional development which provides candidate teachers with simulated classrooms with simulated students based on pertinent attributes of real students (e.g., special education status, introverts, ADHD, disruptive behavior). As shown in Exhibit 14, candidate teachers work with the simulation to develop and test their pedagogical strategies for differentiating instruction and behavioral interventions matched to the needs of the "student." This training can provide teachers with important critical thinking skills needed to set up a positive learning environment that is adaptive to individual students.

Personalized Learning at Scale: Michigan's Education Achievement Authority and Agilix Buzz

In 2012, Michigan's Education Achievement Authority (MEAA) began an initiative whereby the lowest achieving schools would start to become part of a statewide education system. Changes to the schools include the placement of new principals, more school autonomy, extra funds, the creation of parent committees at each school, and access to new technologies that enable more individualized learning.

As part of this initiative, the MEAA created a partnership with Agilix, using their *Buzz* platform to develop what they call "personalized learning at scale." Buzz provides a digital learning environment supported by teacher intervention. Major design principles are that students are grouped by readiness (not grade level), master content at their own pace, choose their own learning path, provide teachers with real-time feedback about how they are feeling about their academic progress (see exhibit below), participate in a learning community with peers, and get immediate feedback from the system about their productivity and progress. Students work from their own personalized learning plan, following online, interactive curriculum. Teachers receive ongoing and immediate feedback about student progress, productivity, and affective states. Teachers can use this information to intervene quickly with highly individualized strategies.

MEAA is currently using this approach with approximately 11,000 students at all grade levels and all subjects. For additional information, see the presentation from the White House Educational Datapalooza event (http://agilix.com/buzz-white-house/).

Screenshot from a Student's Interaction with Agilix Buzz

This is a screenshot of the daily assessment that students fill out about their learning experiences. This information is sent directly to the teacher to help him or her personalize learning interventions. Note in the background data is also displayed about the student's progress and productivity.

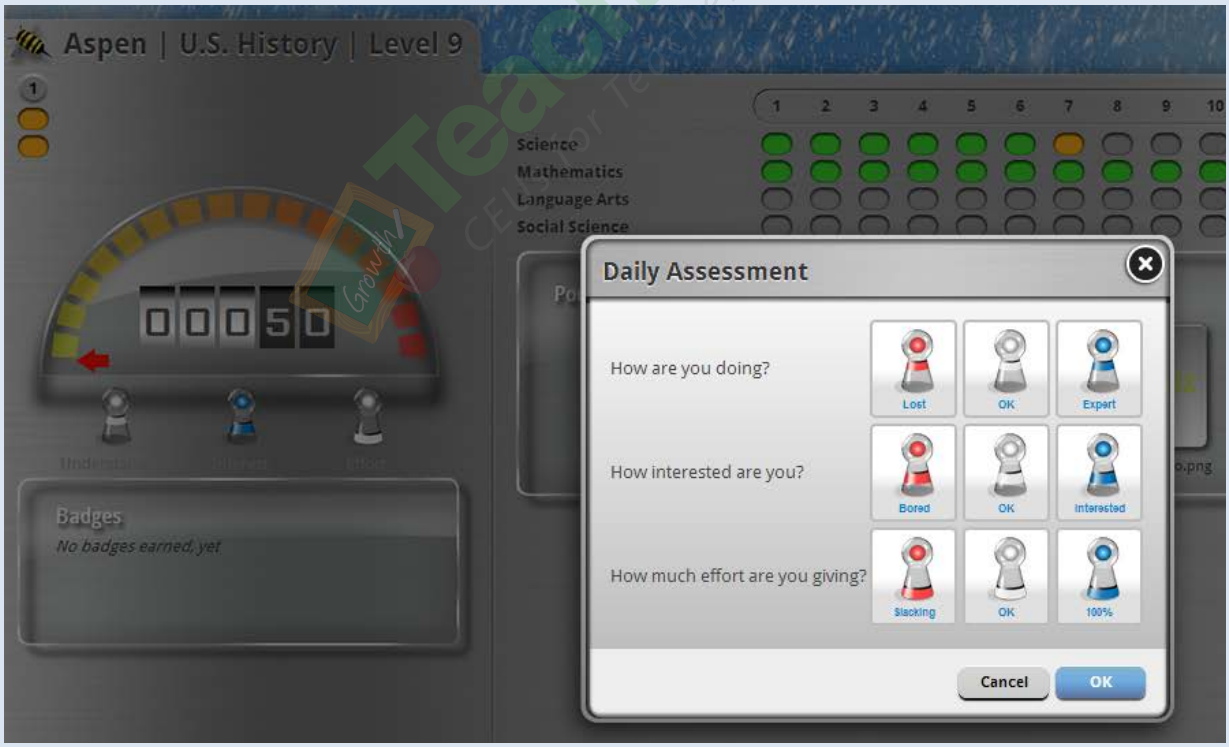
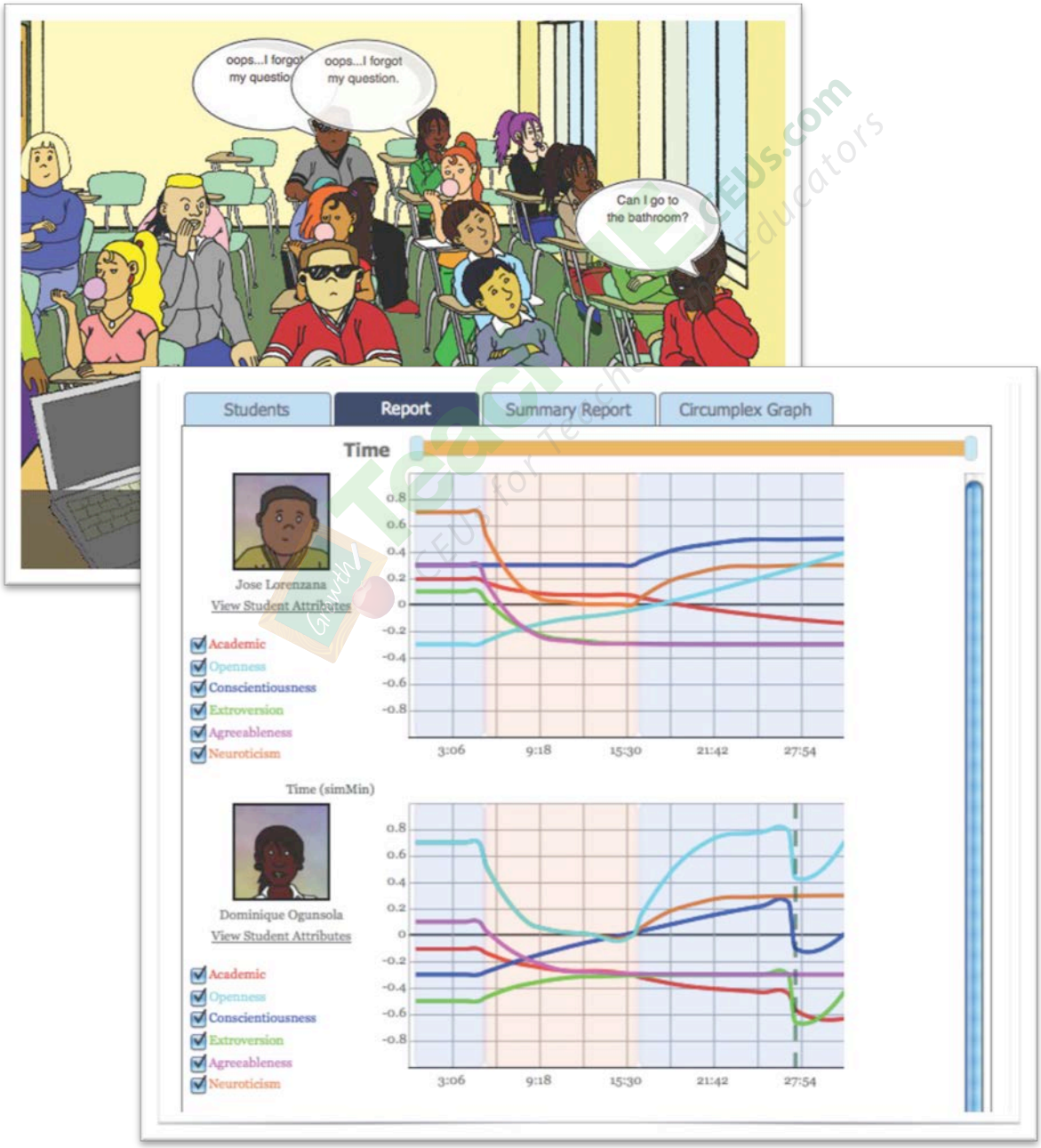


Exhibit 14. Training pre-service teachers using the SimSchool platform

During a SimSchool simulation, pre-service teachers design and execute lessons that unfold in a virtual classroom of students. Each virtual student has predispositions that the teacher must accommodate during both planning and execution through altering qualities such as lesson pace, task differentiation, and speaking tone. Following a lesson, teachers can analyze and reflect on the academic and psychological impacts of their decisions. Blue and white shading signify the shifting of student tasks over time. The colored lines trace psychological and academic impacts from records taken every ten seconds. The dotted line shows where the user talked to Dominique and the impact of this interaction on her attitude.



- **Digital learning environments that promote grit, tenacity, and perseverance through motivating learning environments.** Video games—which provide opportunities for students to be immersed in simulated worlds, interactive stories, engaging visual environments, playful collaborations with other players, vividly designed avatars and personas, and optimally challenging tasks that are adaptive and provide immediate feedback—are a new learning technology that holds great potential for supporting grit, tenacity, and perseverance. Steinkuhler (n.d.), for example, demonstrated that middle school students who tested well below grade level in reading were willing to persist within an engaging video game to comprehend text several grade levels above their own. See callout box for example of *Quest Atlantis.*

Quest Atlantis

Quest Atlantis (QA) (http://atlantisremixed.org/) is a 3D multiuser, computer graphics learning environment that utilizes a narrative programming toolkit to immerse children ages 9 through 15 in meaningful inquiry tasks. It is intended to engage students in a form of transformational play comprising both online and off-line learning activities, with a storyline inspiring social action. QA's design principles draw from both commercial gaming and important findings in the learning sciences about learning and motivation. Inside the game, students travel to virtual places to engage in educational activities called "quests," in which they become empowered scientists, doctors, reporters, and mathematicians who have to understand disciplinary content to accomplish desired ends. As part of their quests, they also have the opportunity to talk with other students and mentors, and build virtual personae. According to QA's website, more than 65,000 students have participated in the project, and QA has demonstrated learning gains in science, language arts, and social studies. Teachers and students have also reported increased levels of engagement and interest in pursuing the curricular issues outside of school.

- **Digital learning environments that teach about or promote academic mindsets.** As discussed above, there is a growing set of interventions based in social psychological theory that target the development of productive academic mindsets. While most of the interventions are paper-based, at least one involves using technology. As discussed above, *Brainology* (http://www.mindsetworks.com/) provides an online interactive workshop that teaches students about the "growth mindset." A series of instructional units teach that the brain grows like a muscle with effort and practice. Students are provided a series of activities and opportunities to reflect in an e-journal (Paunesku et al., n.d.). Another example is *Transforming Engagement of Student Learning in Algebra* (TESLA) (http://teslahgse.wordpress.com/), led by Chris Dede at Harvard University. The project focuses on a 4-day mathematics intervention for students in grades 5 to 8. The research examines Multi-User Virtual Environments (MUVEs), game-like activities in which students are immersed in a 3-dimensional virtual environment, either taking on the identity of a science, technology, engineering, or mathematics professional to solve puzzles, or vicariously observing others solving the puzzles. In the most interactive MUVE induction, puzzles incorporate cognitive scaffolds related to difficulty and motivational scaffolds to

build self-efficacy. Moreover, activities are designed so that successful completion is dependent on students' perseverance.

- **Digital learning environments that teach about or promote learning strategies.** A number of technologies are emerging that target learning strategies, either as a general skill or embedded within content learning. As discussed above, Morisano et al. (2010) reported on *Self Authoring* (http://www.selfauthoring.com), a web-based program for struggling college students that provided eight steps for having students elaborate on their desired futures, specific goals related to those futures, plans for achieving them, and commitment to achieving them. As discussed in Chapter 3, the *Learning Kit Project* (Winne et al., 2006) (http://www.learningkit.sfu.ca/) developed *gStudy*, a system with a suite of tools to support self-regulated learning when students engage with any multimedia information (text, diagrams, charts, audio and video clips) regardless of the content domain. gStudy tools support analyzing, classifying, indexing, and evaluating information. Features of the system include annotation capabilities for multiple types of media, a chat tool for structured conversations with peers, and coaches that attend to and give feedback on study techniques and learning strategies. gStudy has been used with elementary, middle school, high school, and undergraduate students. *WISE* (see callout box below) provides a project-based inquiry science learning environment that integrates the development of self-regulated learning and agency with learning of science inquiry skills.

WISE

The Web-based Inquiry Science Environment (http://www.wiseeducation.org/) is a technology-rich project-based inquiry science learning environment that integrates the development of self-regulated learning and agency with learning of science inquiry skills. It supports the design and implementation of visualizations that provide multiple rich occasions to press students to develop explanations about the real-world and personally relevant questions. WISE features reading and writing prompts to promote autonomous engagement in scientific practices. Supporting development of metacognitive skills, hints and embedded assessments ask students to predict, observe, explain, reflect, and evaluate the work of their peers. Argument organizers and explanation tools, such as Idea Manager, support students in collecting multimedia information and organizing ideas into coherent arguments using evidence. MySystem allows students to illustrate sequences of events and construct models to explain scientific phenomena. Students can create additional representational forms with the WISE Draw & Flipbook Animator.

Teachers are also provided data to help adapt to student learning needs. With WISE teacher tools, such as the Progress Monitor, teachers can view student work in real-time and identify students who need additional attention. Teacher grading and feedback tools support autoscoring of embedded assessments, as well as sending personalized feedback to students. Curriculum projects can be customized for particular classroom contexts using the WISE authoring tool.

WISE 4.0 is built on a scalable, open source architecture that supports a wide array of learning technologies and extensions to other learning environments. It is optimized for running in web-based environments using lighter weight components (e.g., Flash or Java applets) in technology-challenged settings (Slotta & Aleahmad, 2009). The publically available website currently contains over 30 WISE projects spanning Earth, physical and life sciences for elementary through high school students. For more than two decades, WISE curricula have been tested in middle school and high school classrooms in multiple school districts, and research has shown that these units improve student learning (Linn, Lee, Tinker, Husic, & Chiu, 2006).

- **Digital learning environments that promote the development of effortful control.** As discussed above, there are a variety of computerized training tools in which children play computer games that progressively increase demand on functions such as working memory and impulse control. One example discussed above is *CogMed* (http://www.cogmed.com/), which has been demonstrated to be successful for young children.

New and emerging technologies provide many different types of resources to support students' perseverance. While several of these programs have demonstrated impacts on learning, there is still much work to be done to more fully engage the potential of technology.

Moving Forward

In this chapter, we explored roughly 50 approaches practitioners and researchers are developing and testing ways to promote and/or teach grit, tenacity, and perseverance—through structuring contextual factors, bolstering psychological resources, or some combination of both. We found programs in both formal and informal learning environments, some of which had integral technology components. Some approaches integrated teacher professional development elements as well. Interventions spanned the age range. Effortful control and executive function interventions were geared primarily for preschool and early elementary school. Mindsets and learning strategies interventions were geared toward older students from middle school through postsecondary school. Some of the programs we investigated were designed to promote noncognitive factors themselves, and some programs targeted noncognitive factors embedded in the learning of STEM content. Interventions targeted a range of student populations. Many were intended for underserved students of various types, while many were implemented with more mainstream student populations.

There are substantial data available about impacts of these programs. We can divide these programs into three categories. The first category of programs has research or evaluation data that shows impacts with respect specifically to noncognitive factors and, in most cases, academic achievement. These programs include most of the school readiness programs, academic mindset interventions, learning strategy interventions, and many of the digital learning environments. In research on these approaches, researchers' experimental manipulations are the active noncognitive ingredients, so it is possible to make inferences about causality. Most of the alternative school models and some of the digital learning environments only had achievement data available. While this data is important and compelling, these interventions are complex, and it is not possible to isolate the potential impacts of the noncognitive factors themselves. For the rest of the interventions, particularly the out of school programs, approaches are relatively new and/or have limited funding, and provide only anecdotal evidence of success. While the findings in this chapter do not establish grit, tenacity, and perseverance as transferable competencies, taken as a whole, the findings provide a source of optimism about what is possible.

Conclusions and Recommendations

This report has investigated practice and research around grit, tenacity, and perseverance across educational communities. The goal was to distill the critical themes, questions, conclusions, and recommendations around theory, measurement, and the design of learning environments, with an eye toward identifying potential new roles for technology. In the sections below, we discuss specific conclusions and recommendations tailored to the needs and responsibilities of educators, administrators, policymakers, technology designers, parents, and researchers.

Need to Prioritize Grit, Tenacity, and Perseverance

Across the board in research, practice, policy, industry, and popular culture, there is an emerging and convergent recognition that noncognitive factors—and particularly grit, tenacity, and perseverance—should play an essential role in evolving educational priorities. American children in the 21st century need support as they navigate a variety of challenges unprecedented in history. Students in high-poverty areas face particular challenges of stress, limited social support, lack of critical resources, and psychological disempowerment and disenfranchisement. However, regardless of socioeconomic conditions, all students can encounter difficult challenges and setbacks throughout their schooling as they learn conceptually complex material, deal with distractions, persist through academic assignments that are important but not necessarily intrinsically interesting, manage competing demands, and prepare themselves for the complex and rapidly changing 21st-century workplace. The test score accountability movement and conventional educational approaches have tended to focus on intellectual aspects of success, such as content knowledge. However, this is not sufficient. If students are to achieve their full potential, they must have opportunities to engage and develop a much richer set of skills. Indeed, a growing body of research suggests that noncognitive factors can have just as strong an influence on academic performance and professional attainment as intellectual factors.

This is an exciting time of change and progress with a strong need for growing involvement by all educational stakeholders. New and emerging trends in research, policy, programs, and technology are providing unprecedented opportunities. At the same time, a common theme in the

literature and across all of our interviews with researchers, practitioners, and policymakers, is that there is still much that needs to be done if grit, tenacity, and perseverance are to become a pervasive priority in education. ***There are no quick fixes***—making significant progress requires the efforts of all communities of educational stakeholders and fundamental paradigm shifts in the culture of education.

Conclusion 1: For significant and pervasive shifts in educational priorities to promote not only content knowledge, but also the noncognitive factors of grit, tenacity, and perseverance, there is a strong need for growing involvement and support by all educational stakeholders.

Recommendation 1: Educators, administrators, policymakers, technology designers, parents, and researchers should consider how to give priority to grit, tenacity, and perseverance in curriculum, teaching practices, teacher professional development, programs, technology adoption, and out-of-school support. They should look to the research base for best practices and programs that are mature in development and suitable to local context. Structural supports will need to be enhanced to enable educators to enact best practices and implementation of productive intervention models. Progress will also require outreach to parents and advocacy to all educational stakeholders. Research will need to continue to advance theory, measurement, and the design of technology and learning environments. The conclusions and recommendations that follow provide more specific guidance.

Conclusions and Recommendations for Practice and Implementation

Here we discuss research-based best practices, specific approaches and interventions, and needs for structural supports and outreach. Grit, tenacity, and perseverance can be promoted both through structuring *contextual factors* in the learning environment and fostering *psychological resources* within the student—academic mindsets, effortful control, and strategies and tactics. Educators can approach promoting perseverance *within the learning environment* and/or as qualities that are *transferable competencies* to be taken beyond the environment. While we did not find convincing empirical evidence that these qualities can be taught as transferable skills, we found common operating principles for designing supportive contexts and evidence that contributing psychological resources can, to a large extent, be taught and cultivated. We also found critical needs for structural supports at the policy and institutional level to enable these practices and approaches to be implemented productively, as well as the need for advocacy and parental outreach.

Research-Based Best Practices for Curriculum, Teaching Practices, and Technology

We have developed a set of potentially actionable "best practices" for promoting grit, tenacity, and perseverance within learning environments through curriculum, teaching practices, and/or technology (distilling our findings from theory in Chapter 2 and practice in Chapter 4).

First, students need to have the opportunity to take on long-term or high-order goals that, to the student, are "worthy" of pursuit. There is a wide variety of types of goals students may take on, differing in timescale and complexity, and, depending on students' age, educational needs, the content discipline in which the goals are situated, and so on. One principle is that students find goals worthy of pursuit when they are "optimally challenging"—they require some perseverance to attain, but not so much that they seem overwhelming or impossible. Another principle is that students find goals worthy of pursuit when they are aligned with what students value. To the extent possible, goals should be designed to promote intrinsic motivation through connections to students' interests, values, and personally relevant goals. In many cases, particularly with unfamiliar material, educators need to engage students in activities that bridge from their interests and familiar experiences to the learning objectives to help students attain more complex learning goals. Providing students with choice and autonomy in selecting goals and approaches also can foster intrinsic motivation.

Second, students need a rigorous and supportive environment to help them accomplish these goals and develop critical psychological resources. As students engage in pursuing long-term and higher-order goals, there is a wide range of different kinds of challenges they may encounter, such as conceptual complexity or lack of tactical knowledge, more dominant distractions, boredom, lack of resources, and other adverse circumstances. Students will be more likely to persevere in the face of these challenges when the learning environment is designed to help them deal with these challenges, develop the psychological resources within themselves to deal with challenges more generally, or some combination of the two.

We identified three major categories of **psychological resources** that help students in their perseverance—each of which educators should be attending to as they create the culture of a learning environment that supports perseverance.

1. *Academic mindsets.* Mindsets are how students frame themselves as learners, their learning environment, and their relationships to the learning environment. They include beliefs, attitudes, dispositions, values, and ways of perceiving oneself. Productive mindsets to support perseverance are as follows:
   - *I can succeed at this.*
   - *My ability and competence grow with my effort.*

- *Challenge is inevitable for success.*
- *This work is in line with my interests, values, or goals.*
- *I belong in this academic community.*

2. *Effortful control.* Students are constantly faced with tasks that are important for long-term goals but that in the short-term may not feel desirable or intrinsically motivating. Successful students, by themselves or with the support of others, marshal willpower and regulate their attention in the face of distractions.
3. *Strategies and tactics.* Students are also more likely to persevere when they can draw on specific strategies and tactics to deal with challenges and setbacks. They need actionable skills for taking responsibility and initiative, and for being productive under conditions of uncertainty—for example, defining tasks, planning, monitoring, and dealing with specific obstacles.

The **culture of the learning environment** can promote these psychological resources, most commonly *within* the learning environment, but also potentially as transferable skills to take beyond the learning environment. We identified several productive cultural practices. While not every one of these is critical in all learning environments, educators may be deliberate in providing support that is appropriate for the given goals at hand, within their institutional and other practical constraints.

- Students should be treated fairly and with respect. Adults should show they care about students. Educators should have high expectations that all students will be capable of achieving their goals, with support.
- A "growth mindset" should be foundational to the classroom culture. Praise should always be directed at effort and never at ability. Practitioners should tell students to expect the goals to be challenging and require effort.
- Failure must be framed as an act of learning, and students should be provided opportunities to iterate on and improve their work or approach based on constructive feedback.
- Evaluations of performance should be designed to support perceptions of competence and future expectations of success. It should be frequent so that students receive timely and actionable feedback about their performance and growth with respect to academic achievement, mindsets, effortful control, and use of strategies and tactics.
- To the extent possible, the learning environment (e.g., teacher, technology) should be responsive and adaptive to students' performances and learning needs, offering personalized experiences that provide optimal challenge.
- Appropriate learning strategies that foster planning, reflection, and tactics for dealing with challenges should be discussed and supported. For example, students can be taught or

supported to employ strategies to articulate desired goals, make actionable plans, anticipate obstacles and solutions, reflect on progress, and modify their approach as necessary.

- Students should be provided with structures to help them manage their effortful control and self-discipline. For example, as appropriate for the age level, educators should provide learning spaces free of distraction, help students learn to redirect their attention, and make sure students know what actions they can take when they get stuck.
- Educators should provide students with explicit opportunities to reflect on and discuss their processes and actions, thus fostering metacognition and self-regulation.
- Educators should provide opportunities for students to reflect on how academic activities connect to their own interests, values, or goals.
- Educators may consider using technologies that can support these best practices (see below).

In addition to culture and climate, **tangible resources** necessary to achieve goals are fundamentally important. Depending on the type of goals, materials can include access to particular programs, particular educational technologies, rigorous curriculum, equipment, materials to complete projects, course tuition, or physical facilities where students can do their work. Human resources can include mentoring, tutoring, peer guidance, teachers with particular training, or special services. Time also can be a precious resource—optimal challenges require students have adequate time to grapple with their difficulties, reflect, get feedback, iterate, and try new approaches. Particularly in high-poverty urban areas, many of these tangible resources can be lacking.

Furthermore, educators should be aware that grit is not always necessarily productive, and there are **potential risks and costs** if grit is misapplied. For example, in accountability-driven climates and communities that place extremely high expectations on students, grit may not always be in the students' best interest. Persevering in the face of challenges or setbacks to accomplish goals that are extrinsically motivated, unimportant to the student, or in some way inappropriate for the student can have detrimental impacts on students' long-term retention, conceptual learning, and psychological well-being. Similarly, perseverance that is the result of a "token economy" that places a strong emphasis on punishments and rewards also may undermine long-term grit; in particular, while these fundamentally manipulative supports can seem to "work" in the short-run, when students go to a different environment without these supports, students may not have developed the appropriate psychological resources to continue to thrive. Educators must consider how to protect students from these risks and to gauge and fine-tune practices and interventions.

New and emerging **technologies** can play important roles in promoting grit, tenacity, and perseverance—particularly when their design builds on theory and incorporates these research-based best-practices. Digital learning environments can be particularly well positioned to provide students with opportunities and support for taking on and persevering toward complex goals. For

example, online learning systems can use data about students' ongoing performance, productivity, and experiential states to adapt and personalize instruction to keep it in an "optimally challenging" zone. Such data can also be used to detect lack of perseverance to signal a need for teacher intervention, or be provided directly to students themselves to help them monitor and self-regulate their own learning processes—key opportunities to develop effortful control and metacognitive strategies and tactics for learning. Digital learning environments also can provide critical tangible resources—human, material, and time—for goal attainment that may not otherwise be available to students. For example, online communities can provide access to new social networks of peers and mentors, online repositories can provide necessary information and tools, and digital technologies can provide efficiencies for routinized tasks and free up time for more thoughtful activities. Also, digital learning environments can be designed as powerfully motivating learning contexts, for example, through use of discourse and messaging that is consistent with supportive academic mindsets (e.g., ability and competence grow with effort) or through highly engaging gamification.

Note that while these "best practices" may be backed by research evidence in general, the field still needs coherent methods for integrating these practices into school cultures, teaching practice, discipline-specific curriculum, and technologies. We are well aware that the constraints of traditional school cultures and the resources available in many schools—particularly those intensively focused on accountability and/or dealing with conditions of poverty—can present significant barriers to implementing some of these practices. These will be important issues for researchers, practitioners and policymakers to address as well.

Conclusion 2: Substantial research points to actionable "best practices" to promote grit, tenacity, and perseverance. Note that there is still limited evidence at scale, and the field still needs coherent methods for integrating these practices into school culture, teaching practices, curriculum, and technology—especially under conditions that present significant barriers.

Recommendation 2a: Educators and administrators interested in promoting grit, tenacity, and perseverance should draw on key *research-based best practices,* for example, (1) provide students with opportunities to take on higher-order or long-term goals that are "worthy" to the student—goals that are "optimally challenging" and aligned with the students' own interests, and (2) provide a rigorous and supportive environment for accomplishing their goals. Students should be supported in the psychological resources that will help them succeed—academic mindsets, effortful control, and strategies and tactics. Rigorous and supportive learning environments instill, for example, high expectations, a growth mindset, expectations for challenge and early failure, cycles of constructive feedback and iteration, and a sense of belonging; and support for strategies to plan, monitor, and stay on track. Supports also should include the necessary tangible resources (i.e., materials, people, time). Educators should be aware of potential risks or costs of pushing students in ways inappropriate for their needs.

Recommendation 2b: Technology developers interested in promoting grit, tenacity, and perseverance should also draw on key *research-based best practices* in establishing design principles for new technology. Technology-based learning environments should be designed by interdisciplinary teams that bring expertise, for example, in the learning sciences, software design, and domain-specific content.

Programs, Approaches, and Technologies that Promote Grit, Tenacity, and Perseverance

Educators and administrators may consider adopting or adapting in their own context selections from the wide array of programs, approaches, and technologies that are designed to promote grit, tenacity, and perseverance. As discussed in Chapter 4, we reviewed about 50 approaches and programs, and presented them in five conceptual clusters based on targeted age level, learning environment, and the facets of contextual supports and/or psychological resources promoted. The clusters are as follows.

1. **School readiness programs that address executive functions**. These are programs at the preschool and early elementary school levels that help young children develop the *effortful control* and *executive functions* that are necessary for the transition into formal schooling. Programs reviewed included training with computer and noncomputer games, aerobic exercise and sports, martial arts and mindfulness practices, and classroom curricula and teacher professional development. A key conclusion was that the best approaches to improving executive functions address young children's emotional, social, and physical development together in a supportive environment.
2. **Interventions that address mindsets, learning strategies, and resilience.** These interventions comprise the growing body of research demonstrating that relatively brief interventions (e.g., 2 to 10 hours) can significantly impact students' *mindsets* and *learning strategies* for students at the middle grade levels and higher. Interventions that address academic mindsets include instruction that teaches students that intelligence grows with effort, shifting students' explanations for academic and social challenges from stable internal causes to temporary external causes, affirmation of personal values, exercises that relate course materials to students' lives, and "super interventions" that incorporate multiple approaches. Interventions that address learning strategies include those that foster investment in clarifying goals and anticipating obstacles and planning solutions in advance, development of general study skills to deal with cognitive demands, building a robust set of structures for success, and development of content-specific metacognitive skills. Each of these interventions has been shown to impact mindsets, learning strategies, and/or academic performance.

3. **Alternative school models and school-level reform approaches.** We presented three types of approaches that we encountered in our interviews with practitioners. The first is "character education" school models. Key features of those models include explicit articulation of learning goals for targeted competencies, clear and regular assessment and feedback of student progress on these competencies, intensive professional development to help teachers understand and work with these competencies, and discourse about these competencies infused throughout the school culture and all disciplinary curricula. The second is "project-based learning and design thinking" school models. In these models, students develop competencies through engagement in long-term, challenging, and/or real-world problems that require planning, monitoring, feedback, and iteration. Projects provide opportunities to learn important learning strategies and self-regulation skills necessary for perseverance over the long term to achieve the goals of a given project. Mindsets are addressed inherently in processes of feedback and iteration, and projects are often aligned with students' interests and passions. Both the character education and project-based learning and design thinking models are relatively new. There is strong anecdotal evidence of their success, but further research is needed to determine impacts. The third type of approach is school reform programs. These are organizations independent of schools that provide extensive schoolwide teacher professional development, networks of school communities, strategies to improve school organizational structure, targeted behavioral and academic interventions, and other supports for schoolwide improvement.
4. **Informal learning programs.** We reviewed informal learning programs that provide different kinds of support for students' persistence in schooling through to a professional career. Some of these programs provide structured social support networks for students making the transition from high school to college, emphasizing the principles of belonging to a community engaged in the processes of college exploration, application, and initial college adjustment. Some of these programs provide opportunities for students to engage in activities that support interest and persistence in STEM professions. Some are beginning to teach explicitly about grit, drawing on models similar to those discussed in the character education models above. Some provide additional support to transition to the workforce. In most cases, there is strong anecdotal evidence of their success, but further research is needed to determine impacts.
5. **Digital learning environments, online resources, and tools for teachers.** We reviwed educational technologies aligned with each aspect of our hypothesized model. Examples included digital learning environments that provide optimal challenge through adaptivity; provide digital tools to help educators promote a rigorous and supportive classroom climate; provide resources, information, materials, tools, or human capital to accomplish difficult goals; promote grit through motivating learning environments that trigger interest; teach about or promote academic mindsets; teach about or promote learning strategies; and promote the development of effortful control. Online environments can provide a safety zone

in which students feel comfortable exerting effort, failing, getting constructive feedback, and developing learning strategies such as planning and reflection. Digital learning environments also can be fun to work with and can connect deeply to students' interests, passions, and personally relevant goals. Importantly, they provide resources that allow students from all walks of life to accomplish goals that have never been possible before. Data are available showing impacts of some of these technologies on both noncognitive factors and academic achievement.

Educators may choose to investigate the utility of these types of models for their own contexts, but should do so carefully in the absence of research establishing the effectiveness of these types of interventions at scale, how these interventions may be used with students across different ages, and how such interventions can best be integrated into school culture, teaching practice, and curriculum. Schools and informal learning programs trying out alternative school model approaches should apply continuous improvement practices as part of their efforts. This process means thinking carefully about how they will be able to tell whether or not the character education activities are having a positive effect on their students and collecting data on these indices. It also requires setting aside time to reflect on how to measure grit, tenacity, and perseverance, and how to use the data to inform how character education activities could be refined. Practitioners should expect to go through multiple cycles of program design, implementation, analysis, and refinement.

Conclusion 3: Educators and researchers have demonstrated important successes in promoting grit, tenacity, and perseverance through brief interventions, teacher professional development programs, alternative school models, informal learning models, and digital learning environments. New and emerging technologies can provide opportunities for optimal challenge through adaptivity, promote academic mindsets, teach learning strategies, promote the development of effortful control, and provide motivating environments. Note that further research may be necessary to establish the effectiveness of these types of interventions at scale, how these interventions may be used with students across different ages or learning challenges, and how such interventions can best be integrated into school culture, teaching practice, and curriculum.

Recommendation 3a: Educators and administrators should consider adopting and adapting one or more of these models for their own needs and context. This should be done with caution, incorporating continuous improvement practices that include measuring and reflecting on both model implementation and key student outcomes. Successful models employ the best practices outlined in Recommendation 2 pervasively throughout the learning community.

Recommendation 3b: Educators and administrators should evaluate technology with respect to the degree to which its design is grounded in principles aligned with the research-based best

practices for fostering these competencies. Educators should also be aware of the trade-offs in terms of technology requirements and flexibility in design and use by teachers.

Need for Structural and Systemic Supports, Advocacy, and Parental Support

While the evidence is growing that there are actionable best practices and programmatic approaches to promoting grit, tenacity, and perseverance in many settings, there remain tremendous barriers to implementation. A ubiquitous theme in our interviews and literature review is the need for structural and systemic supports. Some of the major barriers cited in the interviews were:

- Accountability-driven school cultures emphasizing gains on standardized tests may be inconsistent with the practices necessary to promote these qualities.
- Many teachers feel they already have too many standards to cover without adding what can seem to them to be more content. In most schools, short school periods are densely packed with content standards. Students may not have the time to seek assistance, reflect, or iterate on their work.
- Many teachers, particularly in urban districts, have as many as 160 students per day. This can be an insurmountable barrier to allowing teachers to provide the constructive personalized feedback and guidance that can be critical to students' perseverance.
- Most teachers do not have access to professional development with explicit guidance for how they should integrate these practices and approaches into their own unique settings with their particular student populations. Most preservice and professional development programs do not currently explicitly address these competencies.
- Many school cultures have not implemented and supported practices to promote valuing of these types of qualities and some believe they are the responsibility of the parent rather than the school.

Our informants had several specific recommendations. Most centrally, it is essential to provide professional development for administrators and teachers, as well as curriculum materials and technological supports. Also, as time and resources for thoughtful reflection, feedback, and iteration can be an important support for perseverance, other potentially high-leverage strategies may be restructuring school days to have longer periods and increasing school staffing so that teachers have a more manageable number of students. Outreach and inclusion of parents and other community members also can provide important bridges.

Conclusion 4: In this accountability-driven culture, there are a wide range of systemic and structural barriers that prevent broad implementation of many best practices and programs.

Limitations include short school periods with broad coverage of standards, lack of teacher training, lack of time for teachers to plan and collaborate, and lack of parental support.

Recommendation 4: Administrators, federal agencies, and foundations should provide structural supports that will enable educators to enact best practices and implementation of productive models. Administrators and educators need professional development, curriculum materials, and technological supports. Other potentially high-leverage strategies may be restructuring school days to have longer periods and increasing school staffing so that teachers can give individual students more thoughtful feedback and attention. Outreach and inclusion of parents and other community members also can provide important bridges to promote coherence among schools and local communities.

We also identified a need to raise awareness of the importance of these competencies across communities. While "grit" is a "hot" topic in many circles, some of these ideas are still unavailable to the majority of individuals in educational communities around the country. To build the momentum to overcome many of the barriers to implementation, a first priority must be awareness-raising so that teachers, administrators, parents, policymakers, and all others involved in the educational community see these issues as important and become invested in supporting change. Stakeholders who understand the importance of these issues and are passionate about shifting educational priorities, within their own institutions and beyond, need to become proactive advocates for change. It is important to realize the potential impacts of spreading the word and outreach to the community—to gain buy-in, tangible help and support for students as they pursue big goals, financial resources, and political support.

Also, researchers often have extensive knowledge about what works and does not work in schools, and it is the research community's responsibility to translate these findings so that the public can understand them, recognize their importance, and marshal the resources for change. Anderman (2011) presents 10 strategies for how researchers can engage with the broader community:

> (1) Present research to practitioners via workshops. (2) Provide assistance to a local superintendent. (3) Write an applied article for practitioner-oriented journal. (4) Inform the public relations office at your institution about your area of expertise. (5) Work collaboratively with teacher educators. (6) Advocate for principles of educational psychology in teacher-intern programs. (7) Inform legislators of your research. (8) Talk about your research conversationally with others—in person and via social media. (9) Work with APA, AERA, and other organizations to influence accreditation standards (NCATA, TEAC), certification standards, and government policy. (10) Present research findings at practitioner-oriented conferences (p. 188).

Conclusion 5: While there is a great deal of work in this area broadly, the importance of grit, tenacity, and perseverance in education is not necessarily widely known, and stakeholders at many levels may not understand the importance of investing resources in these priorities. In many settings, awareness-raising is necessary so that teachers, administrators, parents, and all other stakeholders in the educational community see these issues as important and become invested in supporting change.

Recommendation 5a: Educators, administrators, and parents who understand the importance of these issues and are passionate about shifting educational priorities, within their own institutions and beyond, need to become proactive advocates for change in the educational community to gain buy-in, tangible support for students as they pursue big goals, financial resources, and political support.

Recommendation 5b: Researchers need to actively translate important findings to be accessible and actionable. This brief presents Anderman's (2011) 10 strategies for outreach as a path for community engagement.

Additionally, parents and guardians can play a direct and important role in promoting their children's grit, tenacity, and perseverance. *A systematic exploration of the complex roles of parents and the home environment was outside the scope of this report.* However, some important themes did emerge in our interviews. First, some of the research-based best practices also can be employed in the home as parents work with their children around academic goals. For example, instilling a growth mindset through consistently praising effort over ability is a simple practice that can have important payoffs. Psychologist Carol Dweck writes on her website for parents at http://mindsetonline.com/forum/parentsteach/index.html as follows:

> What should parents do? Research shows that praising the process—children's effort or strategies—creates eagerness for challenges, persistence in the face of difficulty, and enhanced performance. Next time you are tempted to tell your child that he or she is the next Einstein or future Picasso, stop yourself. Instead, take the time to appreciate what they put into their work, not what the work means about their innate brains or talent. Ask them how they went about it and show them how you appreciate their choices, their thinking process, or their persistence. Ask them about strategies that didn't work and what they learned from them. When they make mistakes, use these as occasions for teaching them to come up with new strategies. When they do something quickly, easily, and perfectly, do not tell them how great they are. Tell them, "I'm sorry I wasted your time on something too easy for you. Let's do something you can learn from." Look for ways to convey your valuing of effort, perseverance, and learning—rather than some empty display of ability. Instead of false confidence in fixed ability, these methods will foster an appreciation for the true ingredients of achievement.

Parents can also support children in structuring their home work environments to support effortful control by minimizing distractions. Also, some of the programs we reviewed, such as the character education models, involved parents explicitly through outreach activities that brought parents into the discourse about noncognitive factors. It can be a powerful support for students to bridge between school and home as they develop new capabilities. Furthermore, parents can seek out some of the intervention models, particularly informal learning programs, as resources for their children. Parents are also cautioned that there are no quick fixes around developing these capabilities—these take consistent cultivation over the course of childhood and adolescence.

Conclusion 6: Parents and guardians can also play a direct and important role in promoting their children's grit, tenacity, and perseverance. A systematic exploration of the complex roles of parents and the home environment was outside the scope of this report. However, some important themes did emerge in our interviews.

Recommendation 6a: Parents may employ some of the research-based best practices at home as they work with their children around academic goals. For example, instilling a growth mindset through consistently praising effort over ability is a simple practice that can have important payoffs. Parents can also support children in structuring their home work environments to support effortful control by minimizing distractions, and can seek out some of the intervention models, particularly informal learning programs, as resources for their children. Parents are also cautioned that there are no quick fixes around developing these capabilities—these take consistent cultivation over the course of childhood and adolescence.

Recommendation 6b: Educators implementing programs to promote grit, tenacity, and perseverance should consider outreach to parents and guardians as an important support for students as they develop new capabilities. Parents can continue and support discourse around noncognitive factors. In some contexts, parents may need to be educated about best practices.

Conclusions and Recommendations for Research

While there has been extensive work already, there remain critical gaps in the research and unanswered questions. The following sections discuss key emergent conclusions and recommendations for research.

Need for Conceptual Clarity and Theoretical Refinement

One of the biggest challenges encountered by anyone seeking to make progress in this field—researchers, practitioners, and policymakers alike—is the "Jingle/Jangle" Problem. "Jingle" occurs when the same term is used to refer to different concepts, and "jangle" occurs when

different terms are used for the same concept. For example, there is a wide range of terms related to grit, such as tenacity, perseverance, persistence, conscientiousness, engagement, autonomy, motivation, self-discipline, self-control, delay of gratification, self-regulation, and so on. In some cases, different terminology may refer to concepts that actually have important differences; in other cases, different terminology may reflect similar ideas but be based in different theoretical traditions; in yet other cases, the same terminology can have different meanings in different communities of practice. Many of the researchers, policymakers, and practitioners interviewed asserted that this lack of consistent terminology presents a barrier to collaboration and progress. The confusing terminology makes it difficult to (1) decide what exactly to address in practice, (2) know how to assess impacts, and (3) synthesize research findings.

Research is needed both to clarify the distinctions that are actually critical for practice, and to construct consolidated frameworks that unify concepts and findings. Researchers such as Angela Duckworth are providing greater clarity in the field by examining empirically subtle differences among constructs such as self-discipline and self-control, and by conducting studies that tease apart the various subcomponents of conscientiousness. The recent literature review released by the University of Chicago Consortium on Chicago Schools is an example of a unifying framework that moves the field significantly forward in making sense of all of these concepts as an interrelated network of ideas and practices.

Conclusion 7: Across communities of practice and research traditions, inconsistency in conceptual terminology is a barrier to collaboration and progress.

Recommendation 7: Researchers should seek to (1) tease apart conceptual distinctions that are critical to practice and (2) construct and work within consolidated frameworks that unify concepts and findings. Collaborative partnerships, working groups, professional conferences, and peer-reviewed publications should be geared to identify and work with unifying themes and common definitions.

There is also a need to develop models of the pathways that grit, tenacity, and perseverance develop and can be supported—over time, in different contexts, and for different types of goals and challenges.

One set of critical open questions is around the developmental trajectories of grit, tenacity, and perseverance throughout childhood and into adulthood. There has been considerable research on early childhood and competencies needed for school readiness, for example, effortful control and executive functioning, as well as significant research on mindsets and strategies in middle school, high school, and postsecondary education. However, many of the experts we interviewed emphasized that more longitudinal research is necessary to develop more coherent models of the developmental pathways of these competencies and how these competencies develop over childhood in different kinds of contexts. Such models would inform researchers and educators in

developing learning trajectories and selecting age-appropriate and context-appropriate interventions for students throughout the schooling years.

Similarly, more systematic research is needed to understand how different contexts impact these competencies and to what extent they can be developed as transferable competencies across contexts. For example, how does the same individual student function across different contexts? How can you take a student who may be failing in one setting and turn him or her into someone who is academically tenacious in another? What are the lasting impacts of interventions when students change contexts?

Furthermore, deep consideration must be given to the fact that grit, tenacity, and perseverance will look quite different depending on the nature of the goals students are striving for and the challenges they face. More research is necessary to understand the nature of perseverance under circumstances of different types of goals, challenges, and setbacks. For example, researchers may develop taxonomies, categorization schemas, or conceptual frameworks to characterize goals, challenges, and setbacks.

Conclusion 8: There is a need to develop empirically based models of pathways for developing grit, tenacity, and perseverance over time, in different contexts, and for different types of goals and challenges. Such work would inform the development of learning trajectories and selecting age-appropriate and context-appropriate interventions.

Recommendation 8: Researchers should conduct (1) longitudinal studies to develop coherent models of developmental pathways in different kinds of contexts, (2) systematic research examining the same individuals striving to accomplish goals in different contexts, and (3) systematic research about the different types of supports necessary for different kinds of goals and challenges.

Need to Explore Deep Integration of Grit with Discipline-Specific Content Learning

An important recurring theme is the need to integrate best practices in promoting and/or teaching grit, tenacity, perseverance with discipline-specific content teaching and learning—whether it is within STEM, language arts, social studies, music, and so on. The NRC report on 21st-century competencies, for example, addresses this concern, making explicit recommendations to integrate domain-specific learning with development of intrapersonal and interpersonal competencies (NRC, 2012). There are several contributing factors:

- A core national concern for education is perseverance in the face of learning challenging discipline-specific content. Students struggle, for example, with challenges around

conceptual complexity, lack of tactical knowledge about how to study, more dominant distractions, lack of motivation, and boredom.

- A practical consideration for most educational settings is that teachers must cover a large number of content standards, leaving little appetite for the addition of learning objectives for seemingly new and different types of competencies beyond their disciplinary content.
- The mindsets and learning strategies in different disciplines will be deeply intertwined with the practices of each discipline. For example, perseverance in a challenging inquiry science project may require extensive planning and self-monitoring grounded in the practices such as designing and conducting investigations and constructing models, whereas perseverance to solve a difficult math problem may require having a toolkit of cognitive mathematical strategies as potential entry points into the problem and a growth mindset.
- Hooks to foster perseverance through interest, passion, and connections to students' everyday lives can differ significantly across disciplines.

When these competencies are effectively integrated in the practice of learning disciplinary content and concepts, there is the potential for learning to be more effective and engaging for students.

Conclusion 9: It is important for students to develop grit, tenacity, and perseverance within disciplinary contexts, for example, as part of how they become proficient in mathematics, language arts, science, music, or sports. Within academic and nonacademic disciplines, there is a need to develop ways to integrate best practices for promoting these factors.

Recommendation 9: Researchers should investigate how to integrate fundamentally with discipline-specific pedagogy, curriculum, and teaching practices the supports to promote grit, tenacity, and perseverance, and key psychological resources (mindsets, learning strategies, and effortful control).

Need to Push the Edge of Technology

Another major theme has been around the roles that new and emerging technologies can play in promoting grit. These are providing opportunities with the potential to advance education far beyond what has been possible before—technologies are increasing the sophistication of assessment and adaptation to individual learning needs, enabling individuals to utilize for their own purposes an unprecedented wealth of online resources and providing access to worldwide interpersonal networking. These affordances provide new ways to promote agency and perseverance for individuals—particularly those traditionally with limited access to resources—toward goals that have previously been unattainable.

There is still much important work to be done. We are just beginning to explore the potential of technologies that are already available, and many new technologies are on the horizon. There is a need for strong interdisciplinary research that integrates and iteratively improves empirically based best practices in promoting and/or teaching grit with the development of digital and blended learning environments.

Conclusion 10: There are important opportunities to leverage new and emerging advances in technology (e.g., educational data mining, affective computing, online resources, tools for teachers) to develop unprecedented approaches for a wide range of students.

Recommendation 10: Researchers should work closely with technology developers to continue to explore how to integrate best practices into new and emerging digital learning environments that are well positioned to promote grit, tenacity, and perseverance, and key psychological resources (mindsets, learning strategies, and effortful control) for a range of purposes.

Need to Expand Assessment Capabilities and Methods

Similarly, the field needs to continue to expand assessment capabilities and methods. As discussed in Chapter 3, assessments of grit, tenacity, perseverance, and associated psychological resources are necessary for a range of purposes—as practical tools for educators and technology developers, as tools for researchers to refine concepts and theory, as tools for program refinement and evaluation, and as diagnostic indicators identifying vulnerable students. There already exists a range of methods—self-report, informant report, school records, and behavioral task performance—to capture these constructs as dispositional tendencies or sets of processes unfolding over the course of learning. Each of these methods has important benefits and also drawbacks to consider.

Within the larger theme of assessment, four subthemes emerged.

- The advancement of measurement methods is highly integral to the field's movement toward conceptual clarity. As discussed above, the field will benefit from research to clarify the many constructs and definitions in the literature, understand perseverance across different types of goals and academic disciplines, in different types of contexts, and longitudinally across developmental stages. Such research will require evolving measurement methods that can detect and discriminate important constructs.
- As discussed in the *Expanding Evidence* report and throughout this report, the advancement of digital learning environments provides new opportunities for mining the data produced when students work in digital learning environments, and the emerging field of affective computing allows for multiple channels of data integrating behavioral performances, self-report, physiological responses, and eye tracking. Video games also provide an "exhaust

stream" of data reflecting all of a student's moves within the game. While there are many promising methods emerging, the field is new and there is still considerable work to be done before these become inexpensive and practical for widespread use.

- Evidence-centered design (ECD) provides a set of methods and tools for building complex assessments with strong validity arguments. Tools such as design patterns and task templates can help assessment designers and technology developers manage the complexity of the competencies they are aiming to assess and the multiple functionalities of the technologies they are using.
- As new forms of measurement emerge, there are important ethical considerations. As always, privacy is a particular concern, especially when leveraging data available in the "cloud" that users may or may not be aware is being mined. Another consideration is that learners and teachers now have the potential to get new forms of feedback about their behaviors, emotions, and physiological responses. Measurement developers must carefully consider the impacts of releasing such information to individuals and incorporate feedback mechanisms that are valuable, respectful, and serve to support productive mindsets.

These subthemes suggest important general directions for research in the field.

Conclusion 11: There is a critical need to advance measurement methods for several purposes: (1) practical tools for educators and learners, (2) tools for program design and evaluation, (3) instrumentation for research, and (4) diagnostic indicators to provide early warnings to schools about vulnerable students. New and emerging technologies provide important new opportunities.

Recommendation 11: Researchers should continue to investigate how to leverage and augment new technology-based digital learning environments, using methods such as educational data mining and affective computing. Research efforts should include assessment experts, who can apply techniques such as ECD to design and validate measures aligned with advances in theory.

Need for Field-Based Implementation Research at Small and Large Scale

Another major theme is the need for field-based implementation research and evaluation. While there are many programs with strong potential for impacting mindsets, learning strategies, and effortful control, there is still a gap between the research and how practitioners can use these approaches effectively across a wide variety of settings for a diversity of students. A necessary next step for bridging this divide is for research to expand more directly into implementation research and evaluation. Because this work requires expertise in theory, practice, and research

methodology, implementation research will require multidisciplinary teams including practitioners, as well as researchers.

Clements (2007), for example, provides a broadly-used framework for the steps necessary to develop "research-based curricula." He lays out a 10-phase sequence of research organized into three categories: (1) *a priori foundations*, in which extant research is reviewed and implications are drawn for curriculum development; (2) *learning model*, in which activities are structured in accordance with empirically based models of children's learning of the targeted subject matter; and (3) *evaluation*, in which empirical evidence is collected to evaluate the appeal, usability, and effectiveness of the curriculum. A related research paradigm, *design-based implementation research* (Penuel, Fishman, Haugan Cheng, & Sabelli, 2011), emphasizes focusing on persistent "problems of practice" from the perspectives of multiple stakeholders and ongoing development of capacity to sustain change in institutional systems.

Conclusion 12: While there are many programs demonstrating impacts in particular contexts, there is still a gap between the research and how practitioners can use the various intervention approaches effectively across a wide variety of settings for a diversity of students.

Recommendation 12: Researchers should conduct field-based implementation research at small and large scale to build on the extant research literature and leverage multidisciplinary knowledge of experts in theory, practice, and research methodology. Research methodologies should include small-scale design research grounded in the concerns of everyday practice, as well as larger-scale efficacy studies to establish variations across settings and effectiveness studies to establish impacts at scale.

Need to Explore the Potential Costs or Risks of Grit

In this accountability-driven climate and in communities that place extremely high expectations on students, grit, tenacity, and perseverance may not always be in the students' best interest. For example, persevering in the face of challenges or setbacks to accomplish goals that are extrinsically motivated, unimportant to the student, or in some way inappropriate for the student can have detrimental impacts on students' learning and psychological well-being. Little systematic research has investigated this. Researchers need to explore the different reasons for demonstrating grit and what potential costs may be. Theoretically, there may be important links to the achievement orientation literature that makes distinctions between "mastery-oriented" goals and "performance-oriented" goals. Careful research in this area will help educators learn how to gauge and fine-tune interventions.

Conclusion 13: Little systematic research has explored the potential *costs* or *risks* of grit under certain circumstances for academic achievement, educational attainment, and emotional well-

being. For example, perseverance may be in the students' best interest when mastery-oriented goals are emphasized, but it may be detrimental under some conditions.

Recommendation 13: Researchers should investigate systematically the different reasons for demonstrating grit and potential benefits and costs in learning environments with different goal structures. Potential risks should be explored.

Need for Support for Programmatic and Multidisciplinary Research Portfolios

Given these research needs, it will be important to invest in a programmatic and multidisciplinary portfolios of research geared to making quick advances in the field's understanding of how to promote these qualities in a wide diversity of settings. The researchers, practitioners, and policymakers we interviewed all indicated the need for a broad spectrum of mutually informing research. The expert informants emphasized the need for research to be multidisciplinary and translational with an eye toward transforming practice in the classroom. Effective research and development in this area will require collaborations among experts in theory, practice, research methods, technology, and assessment. Research should also leverage the vast practical wisdom of expert educators. Informants talked about creating ecosystems of innovation and networks of programs that could unify approaches and allow knowledge to accumulate.

Conclusion 14: Researchers, practitioners, and policymakers indicated the need for a broad spectrum of multidisciplinary research on important noncognitive student competencies.

Recommendation 14: Foundations and federal agencies should invest in programmatic portfolios of research that investigate mutually informing research questions spanning the range from basic theory, to intervention and evaluation research, to assessment research. Portfolios should leverage the capacities of multidisciplinary teams and program networks.

Moving Forward

In this brief, we have investigated grit, tenacity, and perseverance—essential to accomplish success in school and beyond. This is an important and exciting time for the field to stop and take stock of this quickly growing aspect of education with a high potential and promise for significantly increasing success for all students. Findings across interviews with key informants and a broad review of the research literature indicate that there is a strong theoretical and practical base for making powerful and impactful advances in the field.

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