Improving teaching practice through education, mind, and selected brain research

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IMPROVING TEACHING PRACTICE THROUGH EDUCATION, MIND, AND SELECTED BRAIN RESEARCH

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Abstract

Around the world, there is an unprecedented opportunity for improving educational outcomes by aligning the practice of teaching with the emerging science of learning. However, a research-to-practice gap persists, and many students, particularly low-income and minority children and youth, are failing to reach their academic potential. The texts submitted with this document (Conyers & Wilson, 2015a, 2016; Wilson & Conyers, 2013b, 2013c) were written as a means of bridging this gap by applying two original frameworks developed through transdisciplinary, practice-based research over 15 years. The first translates implications of education, mind, and selected brain research on how people learn into a conceptual framework and strategies for enhancing teaching and learning. The second focuses on a process for supporting changes in teaching practice and aligns with research and theory from implementation science. These frameworks have been incorporated into professional development programmes for some 100,000 educators and 2,500 teachers from 47 U.S. states, Canada, Europe, the Middle East, and Asia through one of the first two graduate degrees in this field. Studies suggest a positive impact on teaching practice and student learning. The four texts extend the impact of this body of work to a broader audience of teachers, researchers, faculty, and other educational stakeholders and uniquely incorporate research, theory, and examples of practical strategies being applied in real-world settings.

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List of Accompanying Materials

This thesis submission includes two parts—first, the Critical Commentary and, second, copies of the published works as follows:

> *Five Big Ideas for Effective Teaching: Connecting Mind, Brain, and Education Research to Classroom Practice*
>
> *Flourishing in the First Five Years: Connecting Implications from Mind, Brain, and Education Research to the Development of Young Children*
>
> *Positively Smarter: Science and Strategies for Increasing Happiness, Achievement, and Well-being*
>
> *Smarter Teacher Leadership: Neuroscience and the Power of Purposeful Collaboration*

Acknowledgments

I would like to thank Dr. Donna Wilson for her contributions to the four texts submitted with this commentary. Details about our relative contribution to each publication are detailed in Appendix A. I would also like to thank Dr. Armsby and Dr. Boubert for their ongoing support, feedback, and guidance in the completion of this thesis.

Author's Declaration

I declare that all the material contained in this thesis is my own work.

Section 1: [Foundations 1997—2012] Introduction

> If research knowledge about "what works" is to be useful, not only must we assess the value and the quality of the "what" (the intervention), but also we must understand "how" to implement, improve, sustain, and scale-up effective interventions. (Blase, Van Dyke, Fixsen, & Bailey, 2012, p. 13)

Worldwide, a gap persists between research on how people learn and the practice of teaching. This contributes to a situation where many students, particularly low-income and minority children and youth, are failing to reach their academic potential. The texts submitted with this document were written as a means of bridging this gap by applying a synergy of two original conceptual frameworks developed through transdisciplinary practice-based research over fifteen years. The first translates implications of education, mind, and selected brain research on how people learn into structures and strategies for improving teaching and learning. This framework represents the "what" (the intervention) in the context of the quote above. The second is a framework grounded in implementation science that represents the "how" to support the implementation of this intervention. These frameworks have been incorporated into live professional development programmes for some 100,000 educators and online graduate degree programmes completed by 2,500 teachers from 47 U.S. states, Canada, Europe, the Middle East, and Asia. Studies suggest a positive impact on teaching practice and student learning. The four texts described below extend the impact of this body of work to a broader audience of teachers, researchers, faculty, and other educational stakeholders and uniquely incorporate research, theory, and examples of practical strategies being applied in real-world settings.

Portfolio of Publications Submitted with the Commentary

1) With a foreword by cognitive psychologist and Stanford professor emeritus Robert Calfee, the focus of ***Five Big Ideas for Effective Teaching: Connecting Mind, Brain, and Education Research to Classroom Practice*** is on presenting an original conceptual framework for education, based on a synergy of factors that can have a significant impact on improving teaching practice and student learning. These include understanding neuroplasticity, thereby raising expectations of students'

academic potential; appreciating and acting on knowledge that intelligence is multifaceted and malleable; explicitly teaching metacognitive skills and cultivating cognitive assets; and recognizing the influence of health and wellness on learning. Numerous examples of graduates of Nova Southeastern University's Brain-Based Teaching programme putting research into practice are shared.

Reference listing:

Wilson, D. L., & Conyers, M. A. (2013b). *Five big ideas for effective teaching: Connecting mind, brain, and education research to classroom practice.* New York, NY: Teachers College Press, Columbia University. (Times Higher Education recommended reading list, 2013)

2) The theme of ***Flourishing in the First Five Years: Connecting Implications from Mind, Brain, and Education Research to the Development of Young Children*** centers on children's social, emotional, and neurocognitive development in the first five years of life. A conceptual framework for understanding and facilitating the learning cycles of young children is shared. Examples of educators applying strategies based on the implications of mind, brain, and education research are featured throughout the text. This book grew out of a Florida Department of Education initiative I led for early childhood educators, called BrainSMART Early Start and the book *BrainSMART Early Start* (Conyers & Heverly, 1999). A particular focus of this text is the early development of cognitive skills and the cultivation of early literacy skills that are essential for school readiness.

Reference listing:

Wilson, D. L., & M. A. Conyers, M. A. (2013c). *Flourishing in the first five years: Connecting implications from mind, brain, and education research to the development of young children.* Lanham, MD: Rowman & Littlefield Education.

3) ***Positively Smarter: Science and Strategies for Increasing Happiness, Achievement, and Well-Being*** was written to support educators and leaders in their work of improving learning achievement and wellness in schools and communities through the application of practical metacognition and the development of cognitive and affective skills. The dynamic relationship between positive affect, cognitive performance, and wellness is explained, as is the role of malleable intelligence; deliberate practice; neuroplasticity, neurogenesis, myelination, and angiogenesis as pathways for enhancing brain performance; and neurocognitive aspects of developing positive relationships. Taken together, these factors can support a positive shift from an innate talent paradigm to a focus on untapped learning potential. Action assessments and sample strategies for putting research into practice are featured.

   Reference listing:

   Conyers, M. A., & Wilson, D. L. (2015a). *Positively smarter: Science and strategies for increasing happiness, achievement, and well-being.* Chichester, West Sussex, UK: John Wiley.

4) With a foreword by the president of the International Mind, Brain, and Education Society, Mary Helen Immordino-Yang, ***Smarter Teacher Leadership: Neuroscience and the Power of Purposeful Collaboration*** moves beyond the three previous works, which have a primary objective of supporting individual teachers in their own classrooms, to a focus on sharing a fresh vision for school leadership that connects current knowledge from mind, brain, and adult learning research to the process of teacher collaboration, development, and leadership on a school-wide and community basis. The text demonstrates the broad array of leadership opportunities that can exist in schools today, describing a flexible "spectrum of teacher leadership" that identifies the myriad ways in which teachers can contribute to their schools and communities beyond their classrooms. The book also guides teachers to bridge what has been discovered about brain plasticity to the development of metacognitive, cognitive, and affective skills that support learning,

teaching, and collaboration with colleagues. A central focus of this work is on leveraging the "purposeful collaboration" of teachers, teacher leaders, and administrators. This focus is supported by an original framework for analyzing and improving educational systems, as well as a series of vignettes featuring teacher leaders putting some key concepts discussed in the book into practice.

Reference listing:

Conyers, M. A., & Wilson, D. L. (2016). *Smarter teacher leadership: Neuroscience and the power of purposeful collaboration*. New York, NY: Teachers College Press.

Structure of Commentary

The analysis of a need for improving educational outcomes by aligning teaching with the science of how people learn is described in Section 1, together with examples of professional development and graduate degrees designed to bridge this gap and summary of studies of the impact of these programmes. This fifteen-year process of practice-based research supported the development of two original conceptual frameworks. The first, a framework for effective teaching, is detailed in Section 2.1, accompanied by a summary of the research streams that underpin this approach. Second, an original implementation framework that connects to the emerging field of implementation science is described in Section 2.2. A synergy of these two frameworks formed the foundation for the writing the texts accompanying this commentary. Section 3 applies these conceptual frameworks in the context of four texts designed to expand the impact of this work to a broader range of researchers, school of education faculty, educators, and other stakeholders. Details of peer reviews of each text are included in Appendix B. Section 4 outlines conclusions. An extensive glossary derived from the books that define the meanings of key concepts is included on page 79.

1.1 Identifying the Opportunity for a Scientific Foundation for Educational Practice

This section explores the process of researching, developing, implementing, and evaluating the impact of key concepts that underpin the writing of the texts provided with this commentary. It offers a brief historical context and analyzes the need for improving educational outcomes by bridging the research-to-practice gap and aligning teaching with the emerging science of how people learn. Examples of professional development and graduate degrees designed to bridge this gap are presented, along with studies on the impact of these programmes.

Brief Historical Context

The institutional form of public schools that persists today across the United States and other major industrialized nations had taken shape by the early 20th century, decades before scientists began conducting extensive research on how people learn in the context of formal classroom settings. Furthermore, there is little evidence that early pioneering work of researchers and theorists such as Ebbinghaus, Piaget, Binet, Vygotsky, and Luria had been adopted by educators in ways that influence practice. Current policies and practices in school systems often remain founded on assumptions about teaching and learning that had never been subjected to extensive scientific testing in schools and classrooms. In the 1970s, a new science of learning based on research in the fields of psychology, computer science, philosophy, sociology, and other disciplines emerged. A central focus of this field is on bridging research to practice in real-world educational settings. As they studied children's learning, researchers in this new field uncovered evidence that some traditional approaches to teaching might be flawed (Sawyer, 2014).

By the late 1990s, a considerable body of new research on how people learn had accumulated, and reports were commissioned by the U.S. National Research Council to synthesize research findings in this area. These reports included *How People Learn: Brain, Mind, Experience, and School* (Bransford, Brown, & Cocking, 2000). Some key findings were as follows: "(1) Learning changes the physical structure of the brain. (2) These structural changes alter the functional organization of the brain; in other words, learning

organizes and reorganizes the brain" (Bransford et al., 2000, p. 115). The report further outlined these key considerations in supporting the facilitation of learning:

- Effective teaching practice engages with students' preconceptions to capitalize on opportunities to build on prior experiences and to correct any misconceptions.
- Teaching for deep meaning in the context of a conceptual framework supports students' retention, recall, and relevant application of what they have learned.
- Teaching the use of metacognitive strategies guides students to become self-directed learners who can apply what they have learned in novel situations.

In recent years, there has been significant growth in research on the science of learning that has the potential to inform the process for improving education, including a report from the National Research Council outlining the knowledge and skills students need in the 21st century (Pellegrino & Hilton, 2012) and another international report on the brain and learning, *Understanding the Brain: The Birth of a Learning Science* (Centre for Educational Research and Innovation, 2007). The International Mind, Brain, and Education Society launched the journal *Mind, Brain, and Education* "to promote the integration of the diverse disciplines that investigate human learning and development—to bring together education, biology, and cognitive science to form the new field" (Fischer, 2009). Additionally, in the UK, the Education Endowment Foundation released a report, *Neuroscience and Education: A Review of Educational Interventions and Approaches Informed by Neuroscience*, which considers the extent to which "insights from sciences of mind and brain influence, or are close to influencing, classroom practice" (Howard-Jones, 2014).

Persistent Gap Between Research and Teaching Practice

Despite efforts to disseminate this work, a considerable gap continues to separate research on how people learn from classroom practice. For example, Hille (2011) cites an analysis by the American National Council for Accreditation of Teacher Education finding a dearth of content in teacher education programmes about how children learn and little application

of that research in practice. Other researchers have found that few teacher preparation programmes have courses in cognition and learning (Hardiman & Denckla, 2010). As a result of this persistent gap separating research about student learning and standard classroom teaching practice, a significant percentage of students, particularly low-income and minority students, continue to attain lower levels of academic achievement (Berliner, 2009; Darling-Hammond, 2010). Some students arrive at school up to six years behind their highest performing peers in reading and four years in math (Fielding, Kerr, & Rosier, 2007). These students are in need of appropriately challenging curriculum and engaging instruction that support development of higher-order thinking skills in order to catch up with their peers. At the same time, educational research (Pellegrino & Hilton, 2012) indicates that instruction on the use of metacognitive strategies and other higher-order thinking skills that can help improve learning outcomes is also essential for today's students to thrive in the new global economy.

Thus, bridging this gap between research on the science of learning and teaching practice can help provide more equitable educational opportunities for all students. One crucial step in this endeavor is the development of teacher education programmes that connect research on how people learn to conceptual frameworks that guide the implementation of strategies for enhancing student achievement.

Few Teacher Education Programmes Are Yet Bridging the Gap

In the United States, research indicates that of all school-based factors, quality of teaching has perhaps the greatest impact on student achievement (Committee on the Study of Teacher Preparation Programs in the United States & National Research Council, 2010). However, there is little evidence that current teacher education programmes support highly effective teaching practices based on research on how people learn. For example, a review of more than 900 meta-analyses encompassing 52,000 studies and 240 million students (Hattie, 2012) ranks 150 influences on student achievement. Teacher education ranks 134th among those influences. In comparison, the top-ranked factor is self-reported grades and students' expectations about their learning outcomes; the use of metacognitive strategies by students is ranked 14th, and teaching strategies are ranked 23rd. Analysis of

these findings suggests the importance of raising expectations and of teaching students to develop metacognitive and cognitive skills. In addition, this research base supports the impact of effective teaching practices but suggests that teacher education programmes may not yet be adequately training teachers on the use of such strategies. My work has been to advance this omission, while still recognizing that other approaches to improving teaching practice have validity.

The American Association of Colleges for Teacher Education (AACTE, www.aacte.org) reports a membership of some 800 institutions. However, few of those colleges and universities have yet developed graduate degree programmes in fields with a focus on how people learn such as brain-based teaching or mind, brain, and education. My coauthor, Donna Wilson, and I co-developed the first such programme with Nova Southeastern University (NSU) through distance learning, a campus-based program was developed independently at Harvard University in 2002 and another through the University of Texas-Arlington some years later (Sparks, 2012). There are now a small but growing number of universities around the world pursuing research in this area (Sevier, 2013).

1.2 Research and Development of Professional Development Initiatives and Graduate Degree Programmes Aiming to Bridge the Research–Practice Gap

The NSU graduate programmes mentioned above were researched and developed over time after I reviewed multiple research sources, including the National Research Council report on *How People Learn: Brain, Mind, Experience, and School* and published *BrainSMART: 60 Strategies for Boosting Test Scores Increasing Student Learning* (Conyers & Wilson, 2000) as a way to better translate relevant research and theory into practice. This text formed the foundation for professional development initiatives, including a three-year programme with the Florida Department of Education, called Scholarships for Teachers in Action Research and another with Florida Atlantic University supported by and Annenberg Challenge Grant Award. (The iterative practice-based research and development process that grew from this work and supported the

development of the conceptual frameworks that underpin the published works is described in Section 2.)

The positive results of these initiatives led me to develop with Donna Wilson the curriculum, a series of texts, and instructional videos for graduate degree programmes in Brain-Based Teaching (BrainSMART Programs) with Nova Southeastern University's Fischler School of Education**.** Donna brought in her experience as a former university chair of education. Her research interests included cognition and motivation, with a focus on the learning of students at-risk. In 2002, these programmes, delivered through distance learning, offered the options of a Master of Science or Educational Specialist degree with a major in Brain-Based Teaching (BrainSMART Programmes). Since they were the first of their kind in the United States, the NSU Brain-Based Teaching programmes underwent extensive peer reviews by curriculum committees at the university and as part of the university's process for accreditation with the Southern Association of Colleges and Schools and with the National Council for Accreditation of Teacher Education (NCATE). The NSU Fischler School of Education submitted some of the coursework developed in these programmes as part of its successful effort to achieve NCATE accreditation, which is the highest form of endorsement for teacher education programmes in the United States.

While the programmes discussed above are at the graduate level, the key concepts shared in the published works included with this critical commentary have been well received by students at the undergraduate level. For example, positive feedback has been received for *Five Big Ideas for Effective Teaching* in an unpublished survey with University of Central Oklahoma. Empowering pre-service and in-service teachers with a conceptual framework for connecting the science of learning to the practice of teaching is a central purpose for writing these texts.

1.3 Impact of Graduate Programmes on Teaching Practice

In order to assess the effectiveness of the NSU graduate degree programmes, I led the process of evaluating the impact of teachers' graduate studies on their teaching practice

through studies by two external researchers. (An extended version of the studies of impact is described in Appendix C.)

Objectives

Two external researchers were engaged to evaluate the impact of the programme by conducting a survey of graduates (Harman & Germuth, 2012) and an ethnographic study (Germuth, 2012b). Each study aimed to answer these key questions:

- How and to what extent did the experiences graduates had in the mind, brain, and education programme prepare them to be more effective teachers?
- What impact has the mind, brain, and education programme had on the graduates' teaching practice?

Methods

The quantitative portion of this impact study (Harman & Germuth, 2012) consisted of an anonymous survey administered online; teachers received a link to access the survey within three months of graduation. To gain a deeper understanding of teachers' experiences in and reactions to the programme, an ethnographic study was conducted, consisting of focused interviews with eight programme graduates (Germuth, 2012b).

Data Outcomes

Harman and Germuth (2012) report that 294 graduates earning a master's or educational specialist degree completed the survey, a response rate of 61%. Of these graduates, 254 were working as K-12 teachers when they completed the survey.

Results

Overall in the analysis of graduate responses, major findings emerged on the impact of the programs on their teaching practice:

- Graduates are more metacognitive about their teaching practice.
- Graduates better understand how students learn and can use this knowledge to improve their teaching practice.
- Graduates' teaching practice and overall student outcomes have improved.

Although it was not used in research design, results suggest a positive impact on the four levels of the Kirkpatrick Model (Kirkpatrick Partners, 2016) for evaluating training.

Level 1: Reaction—evaluates how participants respond to the training.
Level 2: Learning—measures if they actually learned the material.
Level 3: Behavior—considers if they are using what they learned on the job.
Level 4: Results—evaluates if the training positively impacted the organization.

Specifically, the ethnographic study suggests a change in Behavior and Results as teachers explicitly teach cognitive and metacognitive skills that increased student learning.

> The graduates reported greater student achievement gains. Six of the seven teachers reported that student achievement, in terms of classroom work and/or test scores, had risen since they had completed their program. All these teachers, regardless of subject, ages taught, or background of teacher and students, credited the degree programs with positively impacting the student learning gains. All teachers further credited the teaching of cognitive and metacognitive skills as a major reason that student achievement increased (Germuth, 2012b, p. 33).

Scholarly Significance

A literature search for impact studies of university degree programs in mind, brain, and education revealed little, perhaps because Brain-Based Teaching/MBE is an emerging field and few such programs are offered (Sevier, 2013; Sparks, 2012). The impact studies involving graduates of the NSU programs suggest that teachers who pursue degrees in this new field can improve both teaching and learning, regardless of subject area, grade level, or student population. Teachers who experienced these programs, which were intended to develop teachers' instructional practices, perceived that they were better able to reach all their students and that student achievement increased. In particular, the program's solutions focus on real-world classroom challenges, an emphasis on understanding the science of how people learn and brain plasticity, as well as providing structures and strategies for supporting the teaching of metacognition and cognitive skills seemed to have a powerful impact on teachers' practice (Germuth, 2012b). I have shared results of these

studies through peer-reviewed presentations at key research conferences. My coauthor has also shared this data at selected conferences (see Appendix D). Results from both of these preliminary impact studies by Harman and Germuth (2012) and Germuth (2012b) align well with more general feedback from students and course lecturers and feedback from other professional development initiatives that informed the writing of the texts included with this critical commentary.

Research Limitations

These studies should be regarded as a preliminary investigation of programme impact. While the quantitative study indicated that the vast majority of program graduates perceived that they had become more effective teachers, indicating a positive change in practice as a result of the programs, these results are based on perceptions and not on other assessments. While the ethnographic study found evidence of change in practice and an increase in student achievement in the classrooms of six of the seven participating teachers (the eighth participant was a parent educator), the scope of the study is limited. Further research needs to be conducted.

The process of researching, developing, implementing, and evaluating the impact of the research-based interventions described above led to two key conclusions. First, that a robust conceptual framework for effective teaching that is grounded in mind, brain, and education research has significant potential for improving teaching practice and student learning. Second, that while a framework like this is necessary, it is not sufficient to ensure sustained changes in practice. To do this, application of a framework for supporting sustained changes in teaching practice grounded in implementation science is required. Next, in Section 2, I describe two original conceptual frameworks that can work synergistically to support improved educational outcomes.

Section 2: Original Conceptual Frameworks for Connecting the Science of Learning to the Practice of Teaching (the what), and for Supporting Implementation of Changes in Teaching Practice (the how)

The research and development process described in Section 1 supports the two original conceptual frameworks that underpin the texts submitted with this commentary: (1) improving teaching practice by applying implications of education, mind, and selected brain research and (2) supporting implementation of this work through a framework that is consistent with research and theory from implementation science.

Key questions have guided the research and development of these conceptual frameworks, professional development initiatives, graduate programmes, and the texts submitted with this critical commentary:

1. What research, theory, and concepts on how people learn have high value in terms of their potential for improving teaching practice and student learning?
2. How can this theory and research and these concepts be shared with educators in a way that results in actual changes in teaching practice?

These questions put practitioners at the center and focus on providing support in their pursuit of improved teaching practice and student learning.

Since the curriculum of the graduate degree programmes consisted of year-long studies and multiple courses, the key concepts selected for the writing of this series of books represent a small portion of the total research bases, theory, and academic content. The conceptual frameworks that follow contain concepts that were selected on the basis of the strength of the research base supporting them and for the potential for positive impact on improving teaching practice and student learning. These conceptual frameworks are original and have not been previously published elsewhere.

2.1 Conceptual Framework for Connecting the Science of Learning to the Practice of Teaching (the what)

Answering the Question: What research, theory, and concepts on how people learn have high value in terms of their potential for improving teaching practice and student learning?

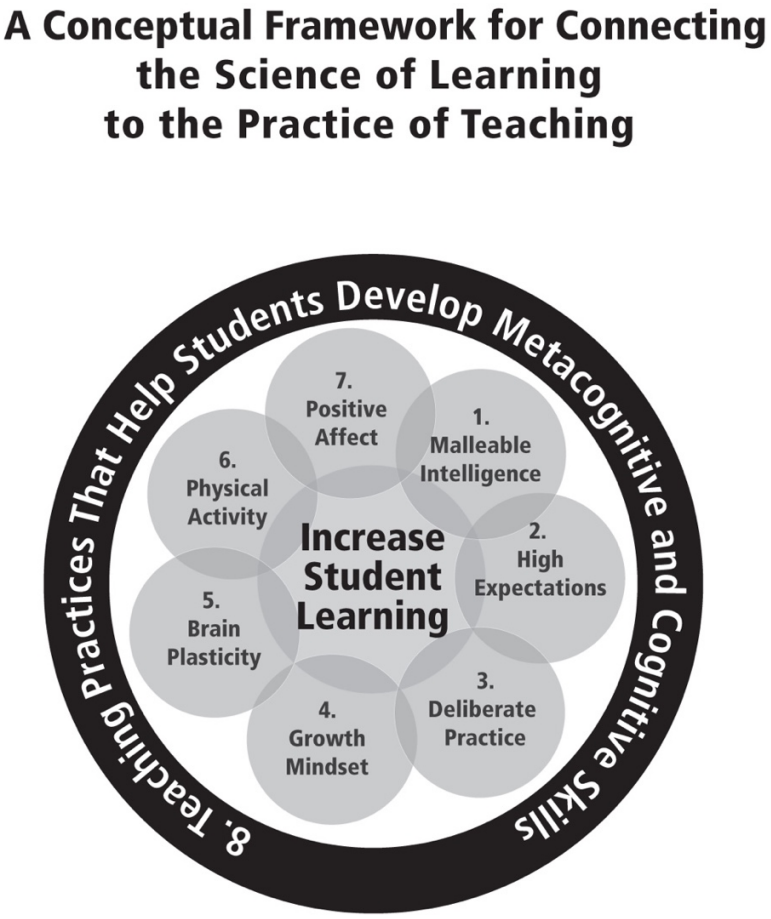


Figure 1

At the center of this framework is increasing student learning. *Learning* is generally defined as "a process based on experience that results in a relatively permanent change in behavior or behavioral potential" (American Psychological Association, n.d.). Eight complementary components are at the core of this conceptual framework. (These

components will be discussed in greater depth in the context of the four texts in this critical analysis). The first seven components support the process that leads to the eighth, the development of metacognitive and cognitive skills that strengthen student learning. There is considerable overlap between each of these components.

Some of the key literature supporting this framework, and which underpinned the theoretical approaches in the published works presented here is detailed in the eight points below.

1. Teaching in ways that align with research on malleable and multifaceted intelligence (Blackwell, Trzesniewski, & Dweck, 2007; Herrmann, Call, Hernández-Lloreda, Hare, & Tomasello, 2006; Hinton, Fischer, & Glennon, 2012; Horn, 1968; Martinez, 2010; Nisbett et al., 2012; Sternberg, 1999, 2007, 2010).
2. Maintaining high expectations by teachers and students (Hattie, 2012; Jones, Bryant, Snyder, & Malone, 2012; Katz,1996, Lusk & Jones, 2011; Rosenthal & Jacobson, 1968; Zambo & Zambo, 2009).
3. Supporting incremental learning gains and, ultimately, the development of expertise through deliberate practice (Duckworth, Peterson, Matthews, & Kelly, 2007; Ericsson & Charness, 1994; Ericsson, Krampe, & Tesch-Romer, 1993; Ericsson & Ward, 2007; Hart & Risley, 2003; Howe, Davidson, & Sloboda, 1993).
4. Teaching with and for a growth mindset as a means for sustaining motivation and effort (Dweck, 2006; Mueller & Dweck, 1998).
5. Understanding by teachers and students that learning changes the structure and function of the brain (Bransford et al., 2000; Centre for Educational Research and Innovation, 2007; Draganski et al., 2006; Giedd et al., 1999; Greenough & Black, 1992; Maguire et al., 2000; Ramsden et al., 2011; Sylwester, 2010; Zull, 2002).
6. Supporting cognitive function and focus through physical activity (Åberg et al., 2009; Castelli, Hillman, Buck, & Erwin, 2007; Grissom, 2005; Hillman et al., 2009; National Center for Chronic Disease Prevention and Health Promotion, 2014; Sibley & Etnier, 2003; Tine, 2014; Tomporowski, Davis, Miller, & Naglieri, 2008).

7. Maintaining student engagement by modeling and eliciting positive affect, optimism, and resilience (Caprara, 2009; Caprara, Steca, Alessandri, Abela, & McWhinnie, 2010; Compton & Hoffman, 2013; Davidson & Begley, 2012; Diener & Seligman, 2002; Hecht, 2013; Killingsworth & Gilbert, 2010; Lyubomirsky, King, & Diener, 2005; Ornaghi, Brockmeier, & Grazzani, 2014; Seligman, 2011; Seligman, Reivich, Jaycox, & Gillham, 2007).
8. Using teaching practices that help students develop metacognitive and cognitive skills that improve academic outcomes (Carlson, Moses, & Breton, 2002; Chein & Morrison, 2010; Flavell, 1979; Fleming, 2014; Hattie, 2012; Keen, 2011; Kuhn, 2000; Morrison, Goolsarran, Rogers, & Jha, 2014; Palinscar & Brown, 1984; Pellegrino & Hilton, 2012; Pianta, Belsky, Houts, & Morrison, 2007; Veenman et al., 2014; Wang, Haertel, & Walberg, 1993).

The above framework connecting the science of learning to the process of teaching represents an important step toward improving educational outcomes. The next step is to apply a conceptual framework grounded in implementation science as a means for supporting continued changes in teaching practice over time.

2.2 Implementation Framework for Supporting Changes in Teaching Practice (the how)

Answering the Question: *How can this theory, research, and these concepts (described in Section 2.1) be shared with educators in a way that results in actual changes in teaching practice?*

Process for Researching and Developing the Implementation Framework

Informing the development of my implementation framework was a meta-analysis of 200 research studies on effective staff development. In this study, researchers found that what was most important was training design and not the role of the trainer, scheduling, or location of the training (Killion & Harrison, 1988; Showers, Joyce, & Bennett, 1987).

Effective design includes (1) presentation of theory or rationale, (2) demonstration or modeling of skill or concept, (3) practice of skill or concept under simulated conditions, and (4) feedback (Joyce & Showers, 1980, 1983, 1995, 2002; Showers et al., 1987; Sparks, 1986). Teachers who participate in training that delivers on these four elements are more than twice as likely to gain the targeted knowledge and skills than if presentations alone are employed (Joyce & Showers, 1995, 2002). When teachers are supported with ongoing coaching, implementation improves considerably.

Putting this research into practice, I led the Scholarships for Teachers in Action Research initiative with the Florida Department of Education over a three-year period. This programme consisted of a five-day workshop annually which focused on solutions to common challenges faced by teachers, the sharing of relevant research, and the modeling of instructional structures and strategies. Participants then worked in teams to create lesson plans that would be enacted in their classrooms. Each year on four subsequent weekends, participants shared reflections on the impact of these lessons in their classrooms and adjustments they made in the content and their teaching approach to better meet the needs of their students. I observed teachers in classrooms, gave feedback, and modeled using the teaching strategies in multiple classroom settings. This collaborative process was built on mutual respect and put the practitioners and their students at the center of the process.

The initiative included an action research component, which was designed to deepen understanding and enable moving research to practice in the local environment. Feedback from participants through surveys and ongoing dialogue refined the framework and added valuable examples of the impact of this work (see Wilson & Conyers, 2010). A similar initiative was supported by an Annenberg Challenge Grant, conducted in association with Florida Atlantic University, with two of the largest school districts in the United States.

Rationale for incorporating action research into professional development and graduate degree programmes. In addition to the application of findings from meta-analyses of factors that support academic achievement, I have incorporated action research as a key component in the professional development and graduate programmes I co-

developed and helped lead. The case for reflective practice and the use of action research in education has deep roots.

Philosopher, psychologist, and educational reformer John Dewey espoused the belief that education's primary aim is the intellectual, moral, and emotional growth of individuals as represented by their contributions to society. To support the achievement of this goal, he considered it to be of critical importance that educators reflect on the impact of their teaching practice (Rodgers, 2002).

Dewey's work in the first half of the previous century was influential in what would eventually become known as action research in the context of education. Psychologist Kurt Lewin is credited with developing one of the earliest theories of action research. (Lewin, 1946; Masters, 1995). In the 1970s, Lawrence Stenhouse and Dan Lortie advanced the application of and need for action research in education. Stenhouse did so with his emphasis on a belief that teaching should be guided by research conducted by teachers rather than outside specialists—in other words, "teacher as researcher" (1975, p. 142). Lortie, in his seminal study of educators, *Schoolteacher: A Sociological Study* (1975), introduced the construct of "an apprenticeship of observation," whereby unlike other professions such as law or medicine, those who became teachers had spent thousands of hours observing teachers and uncritically absorbing norms of teaching that may or may not be effective. My understanding of the potential negative impact of this construct has led me to champion the development of critical reflection and action research by classroom teachers.

In the wake of Stenhouse and Lortie's work, the field has developed considerably in terms of advancing models and frameworks for supporting reflective practice through action research. An approach with a specific focus on this form of research for teachers that has influenced and been incorporated in my work has been by a team of researchers at Kent State University (Arhar, Holly, & Kasten, 2001). Their focus is on action research as a process of critical reflection on practice and the social consequences of what teachers do:

> As a self-directed *and* collaborative journey, AR leads inexorably towards greater professionalism within ourselves, and for shaping the conditions of our profession. This development in our professional lives is guided by critical reflection as we examine ourselves and our practice with an eye toward improving the social consequences of what we do. Teachers are agents of change—movers and shakers, rather than reactors. (Arhar et al., 2001, p. 54)

My rationale for including an action research component in the professional development initiatives and subsequent graduate degree programmes was multifaceted. First, a goal was to support the development of teachers as reflective practitioners who can hone their skills of teaching with metacognition—to move beyond the "apprenticeship of observation" mentioned previously. Second, this process was designed to empower teachers with the self-perception of being researchers in their own right rather than simply consumers of research. Third, this approach was designed to support teachers in their role as team members in shaping interventions and supporting implementation at the local level. Finally, and most importantly, the goal was to give teachers a voice about what needed to be researched and changed in the context of social justice, particularly in the context of those working with low-income, minority, and other students at risk of school failure.

Seider and Lemma (2004) provide evidence of the potential long-term positive impact of action research based on their study of master's degree students. Some key findings were as follows:

1. Teachers maintained the research-oriented mindset gained while they were conducting their action research and continued to apply some parts of the process on an ongoing basis.
2. Teachers' perceptions of their own enhanced professional efficacy persisted for years after they had completed their action research study.
3. Although long-range benefits were not established, there was an immediate benefit to students.

The inclusion of action research as a key part of the professional development and graduate programmes I have co-developed has led to similar findings in terms of informal feedback from participants, graduates, and teacher educators.

My iterative process described above aligns with the emerging field of design-based research, which "allows the researcher to move beyond simply understanding the world as it is, and involves working to change it in useful ways with the broader goal of examining how these systematic changes influence learning and practice" (Barab & Squire, 2004, p. 151). This process was consistent with the four key principles of design-based implementation research, as identified by Peneul and colleagues (2011):

1. *Focus on persistent problems of practice from multiple stakeholders' perspectives.* In the two initiatives I led, long-standing obstacles to increasing student achievement were identified from the perspectives of teachers, students, administrators, and parents.
2. *Commitment to iterative, collaborative design.* Instead of simply requiring educators to implement new lessons and teaching strategies, I worked with teams of teachers to develop and adjust the framework.
3. *Concern with developing theory related to both classroom learning and implementation through systematic inquiry.* The focus of my initiatives was on improving teaching practice and student learning, improving implementation, reflecting on the process, and refining the approach—in effect, connecting emerging theory from the science of learning to classroom practice.
4. *Concern for developing capacity for sustained change in systems.* My central focus was on developing teacher capacity for more effective teaching and for taking the gains we accomplished in collaboration to greater scale across their school sites.

This iterative process of applying feedback from teachers in the ongoing procedure of refining structures and strategies reflects not only design-based implementation research but also a central concept of implementation science, which holds that "the practitioner is

the intervention" (Kelly, 2014). Applying that principle to the development of my implementation framework, the teacher and teaching practices became the core of the intervention.

The implementation framework that I developed is represented in Figure 2.

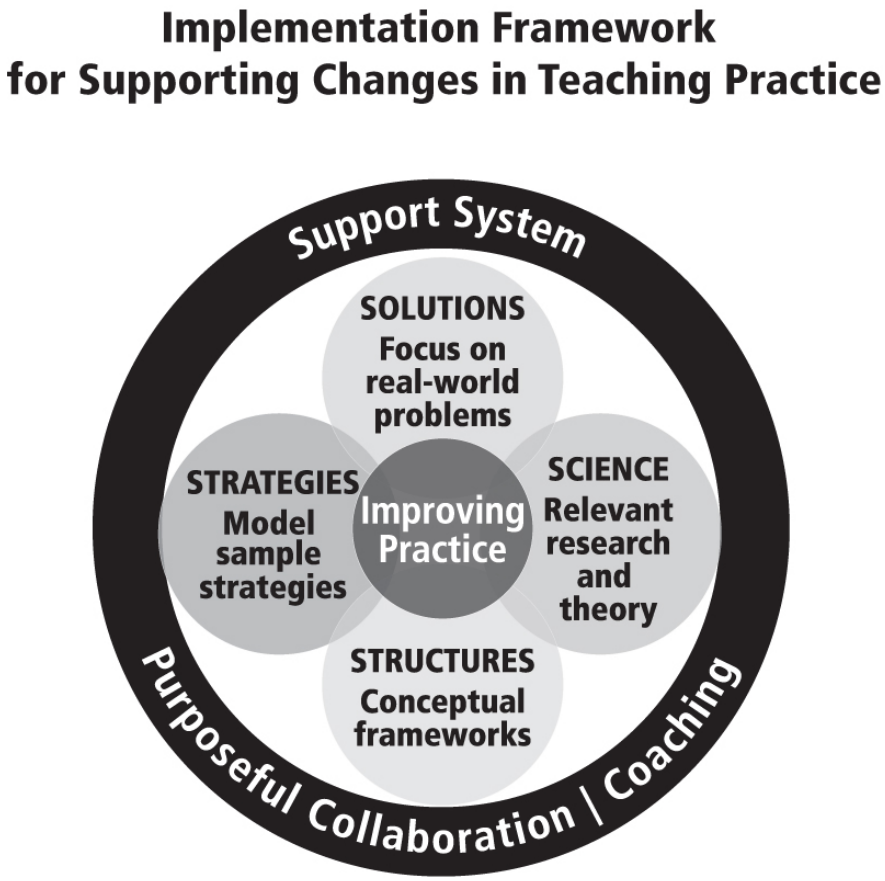


Figure 2

Each of the five components of the implementation framework is described below.

Solutions Focus

Emphasize practical solutions to real-world, high-impact problems identified by practitioners and other stakeholders. Applying Kelly's concept that "the practitioner is the intervention," this framework underscores the need to focus in on what matters most to educators to increase engagement and their willingness to try new approaches and

strategies. For example, teachers in the Florida initiatives and graduate programmes identified the need for teaching practices that would help students focus, retain, and recall information, sustain positive engagement, and become more effective thinkers who could transfer what is learned in one context to another.

Science

Identify relevant streams of research that can inform solutions to these and related problems. In my work, that research explores how people learn, how to teach more effectively, and what implications of research on the growth mindset and understanding brain plasticity may hold for expectations by teachers and students. When educators understand that learning changes the brain and that this process continues across the life span, their motivation to adopt and adapt new practices increases. At the same time, their expectations for their students' learning capacity increase as well. Literature on the impact of teaching with and for metacognition also informed the research and development process of my work.

Structures

Develop conceptual frameworks that support understanding, retention, recall, and transfer of what has been learned. The core concepts explored in *Five Big Ideas for Effective Teaching*, the AEIOU representation of the learning cycle (attention, exploration, inquiry, order, and understanding and use) applied throughout *Flourishing in the First Five Years*, the PEAK strategy (plan, execute, assess, keep improving) in *Positively Smarter*, and the POWER framework (potential, opportunity, work, encouragement, and results) in *Smarter Teacher Leadership* offer examples of useful structures.

Strategies

Share sample strategies that can be readily applied in classroom and other settings and adapted to the needs of students and to different content domains. Each text in the series submitted with this commentary includes a number of strategies that have been shared with thousands of educators and applied in multiple contexts for helping students focus, retain

and recall information, sustain positive engagement, and become more metacognitive thinkers and problem solvers.

Support System

Identify the types of support needed to sustain, expand, and build on improvements. In my analysis of high-performing education systems around the world, it became clear that teachers in these systems benefit from opportunities to collaborate in the development of lessons and ongoing coaching to support the implementation of improved educational practices. Capturing and celebrating teacher achievement is another effective support system for the wider adoption of effective educational strategies. I refer to the application of successful support systems briefly in *Five Big Ideas for Effective Teaching* and more extensively in the fourth book, *Smarter Teacher Leadership*. This framework is applied in the structure of the books detailed in the next section.

The two original conceptual frameworks described above were developed over a fifteen-year period through an iterative process of practice-based research and showed a positive impact on teaching and learning. As a means of increasing impact of this work and reaching more educators, it was important to publish texts that can support university faculty in other institutions who teach in professional preparation programmes, in addition to reaching researchers and teacher educators for graduate programmes. Publishing more widely also provided the opportunity to receive critical feedback from peers from related fields and other institutions. In the next section, these two conceptual frameworks are applied in the context of the four texts accompanying this commentary.

Section 3: [Selected Publications Written 2012—2015] Increasing Impact Through the Publication of a Series of Texts That Connect Research on How People Learn to Teaching Practice

3.1 Overview

> Although researchers have extensive and growing knowledge about how people learn and how to teach them effectively, such knowledge is useless for improving practice unless it gets into the hands and minds of teachers and administrators who need to use it. The American university system has provided incentives for publishing articles in research journals not read by practitioners, and has only occasionally developed strong professional preparation programs that use this research and train practitioners to use it—which is the route by which knowledge would usually travel to the field. (Darling-Hammond, 2010, p. 195)

This section demonstrates how the research-based frameworks described in Sections 2.1 and 2.2 have been applied in a series of texts designed to connect with a broader audience of teachers, researchers, faculty, and other educational stakeholders. These texts uniquely incorporate research, theory, and examples of practical strategies being applied in real-world settings. The content of the texts is grounded in the first conceptual framework. In this commentary, the Solutions Focus, Science, Structure, and Strategies components from the second conceptual framework are used to frame each text. The book, *Smarter Teacher Leadership*, discussed starting on page 45 of this document, has a greater emphasis on the Support System component of this framework with a specific focus on purposeful collaboration and to a lesser extent peer coaching.

3.2 Five Big Ideas for Effective Teaching

Solutions Focus

The focus of ***Five Big Ideas for Effective Teaching: Connecting Mind, Brain, and Education Research to Classroom Practice*** is on providing a solution to the research–practice gap in K-12 education outlined in Section 1 of this commentary. One challenge, from the perspective of many teachers I have worked with, is that while there is a broad

range of educational research published each year, it is often difficult for them to see direct applications to their teaching practice. This text is grounded in the synergy of five big ideas for connecting mind, brain, and education research to classroom practice, and aims to empower educators with a conceptual framework for effective teaching. The focus is on practical application of five essential ideas—neuroplasticity, potential, malleable intelligence, the Body-Brain System, and metacognition. The text is supported by vignettes, examples, inspirational stories from teachers, strategies, reflective questions, and connections between current research on how people learn and classroom practice.

Science Supporting an Education, Mind, and Brain Approach

The transdisciplinary field of mind, brain, and education (MBE), which began to develop in multiple countries in the early 21st century, including the United States, Japan, the United Kingdom, and Germany, draws on diverse research and has potential overtime to provide useful insights for educational systems around the world. However, it was important to me to remain cautious about direct application to changes in teaching practice as the field was currently cast. As Knox (2016) notes, MBE "is a provocative and exciting field that explores the potential impact of neuroscience on education. However, outcomes and relevance of this area of study are far from clear for actual educational practice."

The positive results from the impact studies, other forms of feedback, and emerging research on what influences teacher effectiveness led me to want to reach a broader range of researchers and university faculty with my transdisciplinary frame of education, mind, and selected brain research detailed below. The transdisciplinary nature of this work facilitates the process of moving from research to practice since it places the needs of the practitioner at the center and then seeks relevant streams of research from multiple fields.

Crucial to my thinking was that, while neuroscience in isolation has limited application in classroom settings, findings from the fields of education and mind (psychology) have immediate applications for educators. My approach utilizes limited brain research such as understanding neuroplasticity and the impact of exercise on cognitive function. The big ideas described in *Five Big Ideas for Effective Teaching*, which I have shared in

presentations in the United States, Netherlands, South Africa, United Arab Emirates, the United Kingdom, and Canada, are founded on research from these three large and overlapping areas:

- **Education**, spanning theory and research on areas such as pedagogy, formative assessment, metacognition, student achievement, effective teachers and schools, and teacher leadership. The roots of this research go back to Dewey and have branched out extensively over more than a century to study challenges and opportunities in today's classrooms (e.g., Fielding et al., 2007; Hattie, 2012; Nisbett et al., 2012; Veenman et al., 2014; Wang et al., 1993). I list education first in this research framework because classroom teaching is at the core of my work.
- **Mind (Psychology)**, encompassing theory and research from overlapping fields of cognitive psychology, psychology of classroom learning, educational psychology, school psychology, school neuropsychology, and positive psychology. From the early theories put forth by Piaget and Vygotsky to more recent work by Dweck, Seligman, and Sternberg, a massive accumulation of research relates directly to how people learn so that teachers may draw on it to design lessons that may increase student learning. My work in teacher education draws widely from psychological research, including applications on Ericsson's extensive writing on the development of expertise (Ericsson et al., 1993; Ericsson & Ward, 2007) and Davidson's studies (Davidson & Begley, 2012) on the emotional aspects of learning.
- **Brain,** drawing from theory and research about the physiology and function of the brain, with discoveries that learning changes the brain (Bransford et al., 2000; Centre for Educational Research and Innovation, 2007; Draganski et al., 2006) Woollett & Maguire, 2011) and that physical activity may support the brain and cognitive function (Ratey & Hagerman, 2008; Sibley & Etnier, 2003).

This focus on education, mind, and selected brain research is applied across all four texts described in this document.

Science Supporting Five Big Ideas for Effective Teaching

Metacognition (see Chapter 6, pp. 110–139). Thinking about one's thinking has been identified as the number one characteristic of successful learners (Wang et al., 1993), yet few educators explicitly teach this vital skill (Baker, 2013). To address this, my work includes teaching *for* metacognition, whereby teachers explicitly teach metacognitive and cognitive skills that are crucial for academic success across domains, and teaching *with* metacognition, whereby teachers are actively monitoring and adjusting teaching practice in light of feedback from learners (Wilson & Conyers, 2016), as the accompanying diagram illustrates. The widely taught concept of reflective practice is an aspect of what is meant by teaching with metacognition. In fact, Hartman (2001) describes reflective practice as "teacher metacognition." Reflective practice involves the process of reflecting on teaching methods being applied and discovering what works well for students.

Teaching *with* and *for* Metacognition

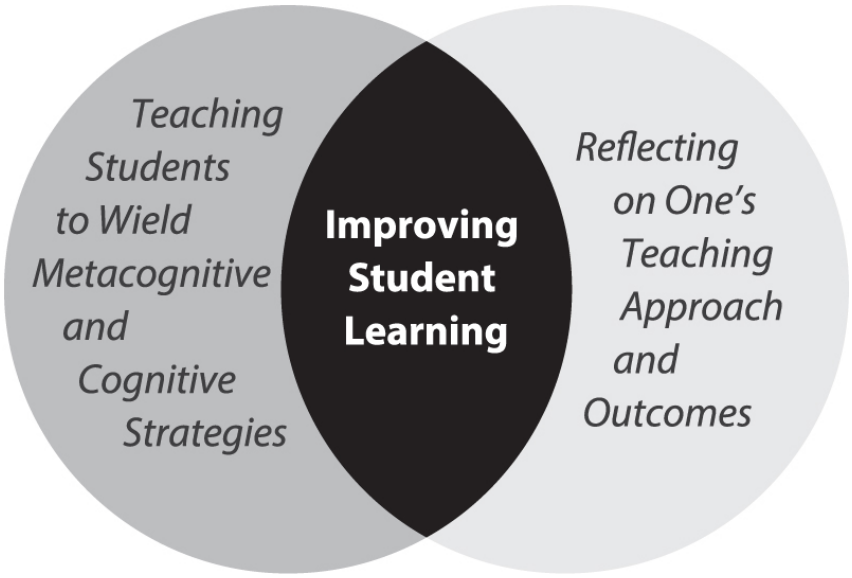


Figure 3

(Graphic from *Teaching Students to Drive their Brains: Metacognitive Strategies, Activities and Lesson Ideas,* Wilson and Conyers, ASCD, 2016)

Hattie, in a recent analysis of 900 meta-analyses (2012) ranked metacognitive strategies as the 14th highest out of 150 influences on achievement; in comparison, socioeconomic

status ranked 45th and class size 113th, and neuroscientists are beginning to identify the areas in the prefrontal cortex that are associated with metacognition (Fleming, 2014). Despite numerous studies on the positive impact of teaching students to wield metacognitive strategies to improve their learning, classroom instruction on metacognition is nowhere near commonplace. In my explorations for the reasons behind the scarcity of instruction on metacognition, I discovered that many teachers consider this concept to be abstract and difficult to communicate to students. Therefore, I developed the metaphor for students and teachers metacognition as a process of learning to "drive your brain" and found that this helped introduce this concept and made it easier to understand. My thinking was that if educators are empowered to incorporate lessons about the power of driving their brains from the early grades on, students will be better equipped with the skills they will need to thrive in school, in their personal lives, and in the working world.

Potential (s**ee Chapter 3, pp. 48–64).** In my work with schools, I found many instances of a mismatch between mission statements that all students can learn and common practices such as placing students in different tracks, some with low cognitive challenges employing redundant worksheets rather than more active, engaging, and challenging learning opportunities. It was important to me to attempt to reduce the divide between mission statements at schools celebrating the potential of all students to succeed and the more deeply held assumptions that belie those sentiments. As part of this process I defined *potential* as "the capacity for acquiring the knowledge and skills to achieve at a higher level of performance in any domain given the proper conditions for success" (p. 53).

Assumptions that run counter to this definition were common, for example, in the practice of reserving instruction on higher-order literacy and thinking skills for students identified as gifted while focusing on basic skills training for others. In schools where I worked, low-income and minority students who initially struggled academically were likely to experience curriculum that is low in cognitive challenge, teachers with low expectations, and little support for learning; as a result, they fell further behind. This finding is consistent with research from others (e.g., Darling-Hammond, 2010). When children begin school without the reading readiness skills their peers possess, those assumptions may lead

teachers away from a focus on the intensive instruction and exposure to reading that these children need to succeed. This is a concern since some students begin school six years behind their highest performing peers in reading readiness (Fielding et al., 2007). At the core of these assumptions are often-unspoken beliefs that low-performing students lack the cognitive potential to read on grade level with high comprehension. As a result, while almost all students have the potential to read on grade level by the end of first grade, 30% do not do so (Allington, 2011). When students fail to read on grade level, they are likely to have challenges in completing schoolwork, thus perpetuating a downward spiral in performance and teacher expectations. Presenting an evidence-based case for the learning potential of all students can help reverse this negative cycle.

Malleable intelligence (**see Chapter 4, pp. 65–92).** I have found that an understanding of the malleability and multifaceted nature of intelligence, which stands in opposition to traditional views of fixed intellect, has profound implications for education. If intelligence is seen to be fixed, then a poor grade on a test can be interpreted as a lack of intelligence; as a result, motivation to work harder to improve performance can be reduced and contribute to a self-fulfilling prophecy of failure to learn. However, when students are taught that intelligence is modifiable and that learning changes the brain, then motivation, effort, and achievement can be improved (Blackwell et al., 2007).

In my review of the research, recent findings suggest that intelligence may be malleable to an extent and that culture and schooling may have a significant impact on intellect (Nisbett et al., 2012). This view considers intelligence to be multifaceted, while another view of intelligence holds that a central measure, known as *g*, predicts and explains academic and life achievement. For example, Sternberg (2010) describes "successful intelligence" as involving four malleable cognitive skillsets: analytic, creative, practical, and memory. Other malleable attributes, such as an interest in developing creative abilities or a willingness to persist, have significant impact on the trajectory of student performance. Furthermore, directing education narrowly on the cognitive skills measured in IQ tests misses out on opportunities to guide students to discover other cognitive styles that may be

more suitable for them and to develop other forms of intelligence, such as their creative and practical capabilities. Widening the view of educators in a way that weaves in other big ideas from this framework supports a dynamic view of learning.

Brain plasticity (see Chapter 2, pp. 28–47). The understanding that the brain is highly adaptive, a property known as *plasticity,* represents a fundamental concept in the MBE field (Hinton et al., 2012). While working with educators, I found that learning about brain plasticity across the lifespan can be immensely inspiring for teachers as they embrace their own capabilities to keep learning and growing throughout their careers. As one teacher noted, it is possible "to teach an old dog new tricks." Further, when working with students, I found that sharing knowledge that learning changes the brain can be very motivating. Student achievement may be enhanced with the recognition that virtually all students can become "functionally smarter" when supported with both effective instruction and their willingness to undertake the sometimes difficult work required to advance academically. Contrary to long-standing assumptions that neuronal growth ends in adolescence, research now suggests that the brain changes throughout the life span in a process described as *experience-dependent synaptogenesis* (Greenough & Black, 1992). Examples of research suggesting changes in the brain as a result of learning include studies of cab drivers learning to navigate the streets of London (Woollett & Maguire, 2011) and medical students studying for exams (Draganski et al., 2006). In my work, I have found that the concept that learning changes the brain positively influences teacher expectations about what their students are capable of learning and about their own capacity to learn at any stage in their career (Germuth, 2012b). This in turn can lead educators to provide more cognitively challenging curriculum and to explicitly teach higher-order thinking skill.

Body-brain system (see Chapter 5, pp. 93–109). To fully optimize student learning, the school environment, curriculum, and daily schedule should support activities for the body as well as the brain and promote a positive, "can-do" outlook. Healthy nutrition, regular physical activity, and positive relationships are not "frills," but key aspects of academic achievement. A variety of studies show that regular physical education enhances school performance, and a growing body of research connects exercise to enhanced frontal lobe

function, attention, and recall (Ratey & Hagerman 2008; Sibley and & Etnier, 2003; Tomporowski et al., 2008). In addition, a positive learning environment in which students feel safe, secure, accepted, and encouraged to take intellectual risks enhances their motivation and participation in learning.

Structure

In order to help to bridge the research–practice gap, the overall organization of the text, around five "big ideas" as guiding principles for effective teaching, was designed to apply a large body of research from across diverse fields to the practical challenges of classroom practice in a memorable and engaging way. The big ideas framework includes a synergy of research and strategies connecting to neuroplasticity, potential, malleable intelligence, the Body-Brain System, and metacognition (pp. 1, 2, 15–21).

Strategies

To help readers to move from research to practice**,** each chapter covering a big idea concludes with a discussion connecting the implications of research on how people learn to classroom practice, with recommendations for practical strategies and teaching approaches that can be applied right away. See page 115, Table 6.1 "Practical Examples of Metacognition in Action." Examples are included throughout the text of programme graduates applying the strategies suggested in their classrooms. Additionally, toward the end of each of the five chapters on the five big ideas there is a section titled "From Research to Classroom Practice" to help the reader connect research to practice (pp. 41–44, 62–63, 83–89, 105–107, and 135–136).

Reference listing:

Wilson, D. L., & Conyers, M. A. (2013b). *Five big ideas for effective teaching: Connecting mind, brain, and education research to classroom practice.* New York, NY: Teachers College Press, Columbia University.

3.3 Flourishing in the First Five Years

> The science is clear. In the first few years of life, a child's brain develops rapidly, driven by a mix of experience, environment and genes. Children will continue to develop throughout childhood and into adulthood, but in the early years their brains are particularly sensitive. By contrast, the science shows that as a child grows older it becomes much more difficult to influence the way their brain processes information (Finnegan & Lawton, 2016, p. 4).

Solutions Focus

The central focus of ***Flourishing in the First Five Years: Connecting Implications from Mind, Brain, and Education Research to the Development of Young Children*** is on providing solutions to the problem of many children beginning school significantly behind their peers in learning readiness. This text grew out of a Florida Department of Education initiative I led, called BrainSMART® Early Start and the book *BrainSMART® Early Start: Building the Brain Power of Young Children* (Conyers & Heverly, 1999). Written primarily for faculty working with early childhood educators and caregivers, *Flourishing in the First Five Years* offers practical strategies for guiding the healthy and positive social, emotional, and neurocognitive development of infants and young children in the years before they begin their formal education. Examples of educators applying these strategies, which are based on the implications of mind, brain, and education research, are shared.

The aim of this book is to provide a resource for connecting research to practice that serves as a supplementary text for courses in Early Childhood Education and provides professionals in the field, including teachers, administrators, and caregivers in early childhood education programmes, an academic resource to inform their practice and interactions with infants, toddlers, and preschoolers.

Science

I conducted an extensive literature review on current research that relates directly to early childhood development. Some key elements include the following:

Development of self-regulation and problem solving (see Chapter 6, pp. 87–113). The idea that each of us is in charge of our brain and that we can steer our thinking to accomplish learning and behavioral goals is at the heart of my approach to teaching self-regulation and early forms of problem solving. Research indicates that toddlers demonstrate rudimentary forms of planning as a path to problem solving (Keen, 2011); by age 3, some children may begin to distinguish between what they "think" and what they "know" (Kuhn, 2000). These developing cognitive abilities can be nurtured and encouraged. Learning self-regulation and self-control can also begin at a young age, and research offers compelling evidence for guiding children to develop these abilities: Two long-term studies (Moffitt et al., 2011; Shoda, Mischel, & Peake, 1990) indicate that young children who demonstrated the ability to delay gratification and exhibit self-regulation had better academic and quality of life outcomes as teens and adults than their peers who did not exhibit these abilities in their early years. Preschoolers who have been taught self-regulation explicitly and in an age-appropriate way also exhibit greater school readiness skills and have an easier time in their early years of education (Blair & Diamond, 2008).

Brain plasticity (see Chapter 1, pp. 1–16). Although experience-dependent synaptogenesis happens throughout life in response to our experiences with people, places, and things around us, infancy is a period of brain development characterized by "exuberant synaptogenesis"; in fact, the synaptic density of 10-month-olds greatly exceeds that of adults (Lightfoot, Cole, & Cole, 2008). (Pruning later eliminates synapses that are not used regularly.) The majority of synaptic development occurs in the first 20 years of life; Sylwester notes that the early years of this period are the time when we learn "how to be a *human being*—learning to move, to communicate, and to master basic social skills" (2010, p. 60). An enriched environment offering a great deal of contact with adults and other children and many opportunities to engage the senses can strengthen these developing brain connections (Eliot, 1999) and facilitate young children's ability to detect patterns and make approximations, to enhance working memory, to self-correct and learn from experience, and to learn to create (Caine, Caine, Klimek, & McClintic, 2015). The capacity of young children's brains to change and learn influences "the developing neural

architecture in ways that support later, more complex learning" (Meltzoff et al., 2009, p. 284).

Early literacy development (see Chapter 5, pp. 67–85). This text emphasizes the critical importance of early, regular exposure to spoken and written language, based on research about the differences in learning experiences across socioeconomic strata. Hart and Risley (2003) conducted a 2½-year study in the homes of 42 families with young children, extrapolating a range of exposure to spoken words of more than 30 million words, with the high to low range equating roughly to family income. In short, children from higher-income families had a much greater accumulated exposure to spoken words than children from poor families. These findings are supported by other studies showing that regular conversations, frequent story reading, word play, and even singing together play a key role in future literacy and language development (Crain-Thoreson & Dale, 1992; Dickinson & Tabors, 2002). Encouraging young children to engage with books and with the acts of writing and drawing also enhances their expectations of their abilities to learn to read and write (Cambourne, 2001).

Structure

A unifying structure presented in this text sets out the learning cycle of young children as a circular five-stage process, represented by the sequence AEIOU: attention, exploration, inquiry, order, and understanding and use (pp. 13–14). This cycle occurs as the human brain becomes aware of new knowledge, processes the concepts and information, and then applies the new knowledge and skills.

Strategies

To bridge the gap between research and practice, the text includes examples of NSU programme graduates applying what they have learned in the context of their schools and classrooms. A core concept explored is the implication of research on metacognition and cognitive skill development with young children. Examples from a curriculum I co-developed to cultivate emerging cognitive and metacognitive skills are included. (This work, which takes the form of stories and accompanying learning activities illustrating the

power of a positive outlook or listening skills, for example, was used by educators in the graduate programme with their own students.) Additionally, at the end of each chapter in a section titled "Practical Tips for Early Childhood Educators" readers learn ways to take the research to practice (pp. 15–16, 28–29, 47–50, 65, 84–85, 111–113, and 135–136.)

To support its research base, the text includes diverse snapshots of how NSU programme graduates are applying what they learned in the context of their schools and classrooms (e.g., pp. 92–93, 97–98).

Reference listing:

Wilson, D. L., and Conyers, M. A. (2013c). *Flourishing in the first five years: Connecting implications from mind, brain, and education research to the development of young children.* Lanham, MD: Rowman and Littlefield Education.

3.4 Positively Smarter

> Education is the wellspring of our health, wealth and happiness. It allows human beings to transcend the physical limits of biological evolution (The Royal Society, 2011, p. 1).

Solutions Focus

In the two years after writing *Five Big Ideas* and *Flourishing in the First Five Years*, some key themes emerged in terms of my observations about the challenges facing teachers, on what was working well for programme graduates in their professional practice and what they were interested in learning more about. These themes are developed in ***Positively Smarter: Science and Strategies for Increasing Happiness, Achievement, and Well-Being*.** In addition to findings from the impact studies described in Section 1.3, my observations were drawn from responses to conference presentations, visiting schools, discussions and ongoing interviews with graduates and the range of topics chosen for their action research projects. I connected this to my analysis of emerging research on factors that can improve learning and teaching practice and the development of expertise:

1. There is a commonly held belief that innate talent is the central driver of performance (Halvorson, 2012; Sternberg, 2007). This remains a persistent impediment to enhancing one's professional and personal endeavors. For example, can all teachers improve their practice, or are "natural-born teachers" the only effective educators? Can children who enter school without the learning readiness abilities of their peers catch up, or will they always be poor performers?
2. Assumptions that the brain is fixed and cannot change can undercut the message that individuals can improve their performance through practice (Dweck, 2006). To counter this well ingrained assumption, I emphasized new research on four pathways for improving brain performance (Fotuhi & Antoniades, 2013).
3. Because students spend only 14% of their time in school (with 33% of their time spent sleeping and 53% at home and in the community, according to Bransford et al., 2000, p. 148), it is essential to share the implications of MBE research and effective teaching and learning strategies with parents and other educational stakeholders. Although this book is designed for educational professionals, it can be used by parents and other family members as well.
4. Evidence from the field of positive psychology suggests that an optimistic outlook can support achievement and motivation (e.g., Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Seligman, 2011). Schoolwork, however, is often focused on curriculum, instruction, and assessment and not the social and emotional aspects of learning.
5. Subjective well-being or happiness is regarded by many as simply the positive feelings that result from pleasant experiences (Compton & Hoffman, 2013; Seligman, 2011). The research base assembled for this book emphasizes (1) the strong connections between subjective well-being, enhanced performance in one's professional and personal pursuits, and physical, mental, and emotional health and (2) evidence that the ability to become happier is within one's control—in effect, a learnable skillset (Davidson & Begley, 2012; Helliwell, Layard, & Sachs, 2013).
6. Physical activity supports cognitive function and improved mood; however, there has been a sharp decline in the amount of physical activity in schools. Trading physical education for more time on core academic learning may actually be

counterproductive to the goal of improving performance (Conyers & Wilson, 2015b).

7. The potential for a metacognitive approach to teaching and learning to improve academic outcomes for students and professional pursuits of adults is not widely known or applied (Baker, 2013). This book aims to make a concept that can be quite abstract more concrete and practical with the concept of practical metacognition, which is introduced, defined, and described in this text.

My aim with this book was to bring together previously disparate lines of research—on the impact of positive affect, deliberate practice and the development of expertise, practical metacognition, social learning, regular physical activity, and healthy nutrition in the context of understanding brain plasticity—to emphasize key themes that influence learning and performance. I selected this range of topics for three primary reasons. (1) Individually, they can have a significant positive impact for individuals, schools, and communities. (2) As discussed in the science section below, these factors can work synergistically. For example, physical activity can improve health and support learning (Centers for Disease Control and Prevention, 2010). Supporting positive affect can improve student achievement; a recent meta-analysis found that programmes focusing on social emotional learning improved behavior and well-being and achieved an 11% increase in academic achievement compared with controls (Durlak et al., 2011). (3) Through effort and the application of effective strategies, individuals and groups can improve their performance in these areas.

Science

Positive affect (see Chapter 2, pp. 41–59). In my experience with students and classroom teachers, I have found that modeling and eliciting positive states supports engagement and attention. The inclusion of positive states as the first component of the BrainSMART model (Conyers & Wilson, 2000; Wilson & Conyers, 2011a) is grounded in educational applications of positive psychology (e.g., Compton & Hoffman, 2013; Seligman, 2011; Seligman et al., 2007). As Immordino-Yang and Damasio write, “the neurobiological evidence suggests that the aspects of cognition that we recruit most heavily in schools,

namely learning, attention, memory, decision making, and social functioning, are both profoundly affected by and subsumed within the processes of emotion" (2007, p. 3). A recent meta-analysis found that programmes focusing on social emotional learning improved behavior and well-being and achieved an 11% increase in academic achievement compared with controls (Durlak et al., 2011).

It was important in this text to clearly communicate that subjective well-being is important in its own right but also may have benefits in terms of performance and physical health (Helliwell et al., 2013). A meta-analysis of 225 papers involving 275,000 subjects concluded that happiness may lead to successful outcomes rather than simply following from them (Lyubomirsk et al., 2005). Countering common assumptions that a positive outlook is largely heritable and beyond our control, Lyubomirsky's research (2007) finds that 40% of our affective responses can be determined through conscious action. Davidson and Begley (2012) suggest that happiness is best viewed as a skill. This diverse research base helps build a strong case for consciously developing the cognitive and metacognitive aspects for supporting subjective well-being individually and at the level of classrooms, schools and communities.

Deliberate practice (see pp. 28, 68, 97, 113–114). A key influence on my thinking regarding learning and the development of expertise in teaching practice has been the work of Anders Ericsson. Challenging the notion of "natural talent," research by Ericsson and colleagues (Ericsson & Charness, 1994; Ericsson et al., 1993; Ericsson & Ward, 2007) indicates that expert performers across diverse fields owe their accomplishments to deliberate practice of at least 5,000–10,000 hours and with the guidance of experienced teachers, coaches, and mentors over time. I had brief communication with Ericsson and, at his request, sent him a copy of *Five Big Ideas for Effective Teaching*; in return, he forwarded several articles to me that were useful in writing this text.

Physical activity (see Chapter 7, pp. 159–176). In my work in schools over the years, I have seen a steady decline in the levels of and opportunities for physical activity by students, and these observations are supported by a review by the U.S. Government

Accounting Office, which found that time allotted for physical education has declined; only 4% of elementary schools, 8% of middle schools, and 2% of high schools offered daily physical education in 2006 (Pekruhn, 2009). At the same time, my reviews of the research suggest that regular exercise supports cognitive performance. Students perform better on reading comprehension, spelling, and math tests when they have the opportunity to participate in 20 minutes of physical activity immediately before their exams, and more physically fit middle-schoolers perform better on assessments of math and reading than do their less fit peers (Centers for Disease Control and Prevention, 2010). In a study of a suburban Chicago school district, Ratey and Hagerman (2008) report that since the district has focused on creating a "culture of fitness" and required daily physical education for all students, schools there have posted significant gains on standardized tests.

Brain plasticity (see Chapter 1, pp. 11–40). In the previous texts, discussions of the implications of brain plasticity for learning potential focused on neurogenesis, or the creation of new neurons, and synaptogenesis, or the formation of neural connections that facilitate the transmission of information in the brain. *Positively Smarter* broadens this scope to include supporting myelination, which influences the speed and transition of brain impulses, and angiogenesis, which can increase the flow of oxygen to the brain. This wider view of how people might enhance their brain function through their thoughts and actions (e.g., committing to lifelong learning, adopting a growth mindset, deliberate practice, and regular physical activity) may shift the view of human potential from fixed to malleable and dynamic.

Structure

I developed several structures and concepts to convey and reinforce the complex, interrelated nature of the research base presented in this text. For example, the phrase *neurocognitive synergy* conveys that through your conscious (or *cognitive*) recognition of your ability to take charge of your brain (*neuro*), you can wield an integrated combination (*synergy*) of factors for becoming more optimistic, a better thinker, and more productive, and healthier (pp. 7, 207). For example, as discussed above by increasing physical activity it may be possible to increase student learning in schools.

I set out two paradigms, the Innate Talent Paradigm and the Untapped Potential Paradigm, as a structure for contrasting two views of ability and intellect as fixed and innate vs. malleable and improvable. The CIA Model offers a practical structure for *controlling* the factors that can make us happier, healthier, and more productive; identifying the *influences* on our outlook and behaviors; and *acknowledging* that which we cannot control (pp. 55–57).

Strategies

This text shares the concept of *cognitive assets*, or thinking skills and strategies that can be taught and learned to improve problem solving, creative endeavors, and learning in school and in life, and presents several such strategies to help individuals and teams to "work smarter" (pp. 123–130). In addition, the PEAK process (for plan, execute, assess, and keep making progress, pp. 207–209) sets out concrete steps to optimize the practical metacognitive approach to goal setting and execution. To apply the research finding that people can reap the benefits of proactively supporting subjective well-being, *Positively Smarter* sets out strategies as well as action assessments (pp. 212–218) for analyzing current performance and charting progress towards goals.

Reference listing:

Conyers, M. A., & Wilson, D. L. (2015). *Positively smarter: Science and strategies for increasing happiness, achievement, and well-being.* Chichester, West Sussex, UK: John Wiley Blackwell.

3.5 Smarter Teacher Leadership

The first three books discussed earlier are primarily focused on helping individual educators improve student learning in their own classrooms. The next step was to explore opportunities for moving the implementation of more effective teaching practices to scale. In my analysis of effective educational systems, I found a recurring theme that a central focus was supporting a system in which teachers collaborated with colleagues to create

effective lessons and assessments as well as to provide coaching to support improved teaching. This was consistent with my own experience of working in high-performing schools. The Educational Specialist degree in Teacher Leadership, which I co-developed with Nova Southeastern University, drew on these findings as well as other streams of research. *Smarter Teacher Leadership* extends the focus of the prior texts to explore systems for supporting purposeful collaboration and peer coaching, thus addressing the key elements of the fifth component of the implementation framework introduced in Section 2.2. This book links to the research themes in the other publications in terms of how it connects implications of education, mind, and selected brain research on how people learn to the practice of teaching and leading by encompassing an understanding of (1) malleable intelligence, (2) high expectations for all learners, (3) deliberate practice, (4) a growth mindset, (5) brain plasticity, (6) regular physical activity, and (7) positive affect, all of which can support (8) teaching for the development of metacognitive and cognitive skills that can increase student learning. However, the text applies these themes specifically in the context of teacher development and teacher leadership and connects to additional research on adult learning and the positive impact of purposeful collaboration.

Solutions Focus

As discussed earlier, the quality of teaching has possibly the greatest school-based influence on student learning (Committee on the Study of Teacher Preparation Programs in the United States & the National Research Council, 2010). A major challenge in education today is that there is significant variation in terms of teacher effectiveness within schools. This variation in some cases exceeds the variation between schools (Hattie, 2015). Therefore, while empowering individual teachers with knowledge and strategies for increasing student learning, as described in Figure 1, Framework for Connecting the Science of Learning to the Practice of Teaching, is necessary for improving achievement in individual classrooms, it is not sufficient to take this improvement to scale within schools, across schools, and across districts. Often teachers tend to work in isolation and receive minimal support and feedback. Furthermore, there are often limited opportunities to share with colleagues their own expertise in terms of strategies for supporting student learning that have been successful. One solution is that of teacher leadership, which has been

described as “the process by which teachers, individually or collectively, influence their colleagues, principals, and other members of school communities to improve teaching and learning practices with the aim of increased student learning and achievement” (York-Barr & Duke, 2004, pp. 287–288). This approach, when connected to the process of improving teaching through education, mind, and selected brain research, has potential to improve the collective expertise of all teachers within schools, thereby positively influencing student learning.

Science

Multiple research streams underpin this work, including connections between neurogenesis, neuroplasticity, and collaborative learning as well as studies on the impact of teacher leadership and purposeful collaboration on student achievement.

Connecting neuroscience to the application of adult learning theories in the context of teacher leadership and collaboration (see Chapter 2, pp. 25–42). The frame for this thesis is improving teaching through education, mind, and selected brain research. Most of the research and theory in support of this thesis is drawn from education and psychology; however, I have also made some key connections to neuroscience that are relevant to teacher learning and collaboration. These include an understanding of neurogenesis, neuroplasticity, and findings from the field of social cognitive neuroscience.

For most of the 20th century, a prevailing assumption was that the adult brain lacked the capacity for neurogenesis, the production of new neurons. A landmark study reported in *Nature Medicine* (Eriksson et al., 1998) suggested that the human hippocampus, a region involved in learning and memory, retains the ability to generate neurons throughout life.

Furthermore, traditional models of neuroplasticity, changes in the brain resulting from experience, held that “the reorganization of brain structures occurred mainly during childhood and adolescence, leaving adults with limited means to learn new knowledge and skills” (Schlegel, Rudelsen, & Tse, 2012, p. 1664). However, a growing body of research is documenting changes in the adult human brain that coincide with the development of

simple motor and cognitive skills as well as complex long-term skills such as learning a new language (Draganski et al., 2006; Lillard & Erisir, 2011; Schlegel et al., 2012; Seidler, 2012; Woollett & Maguire, 2011).

Although accumulating research from the field of neuroscience indicates that adults retain the capacity to generate new neurons and to change their brains and learn new knowledge and skills throughout their careers, there is little evidence that this capacity is well understood by educators and administrators. The idea of the "natural-born teacher"—the belief that great teachers are born and not made—remains commonplace. When this assumption is widely held, there may be little incentive or motivation to invest in teacher learning and development.

In my experience working with educators and administrators, I have found that professional development that explicitly emphasizes that the adult brain is malleable and that teachers have significant capacity to learn new knowledge and skills throughout their careers is motivating and supports positive learning expectations. This is important since Hattie (2015) identified teacher and student expectations as a key component for supporting learning achievement.

Connections between neuroscience and collaborative learning (see Chapter 3, pp. 49–50). A challenge to improving education today is that in many countries, teachers tend to work in isolation with limited opportunities for learning with colleagues. In my review of effective education systems, it became clear that providing such opportunities for teachers and teacher leaders is essential. My work in supporting collaborative learning is informed in part by research from the field of social cognitive neuroscience. Researchers in this field are using brain imaging technologies to discover how the human brain responds to the social world (Lieberman, 2013). For example, an analysis of previous positron emission tomography (PET) studies conducted by Shulman and colleagues (Shulman, Fiez, et al., 1997) led to the identification of a network of brain regions that became more active when the mind was at rest from other tasks. This "default network," which becomes more active by default after other cognitive tasks have been completed, is almost identical to the

network that consistently appears in the brain during social cognition studies (Lieberman, (2013). Lieberman describes this as the *mentalizing network*, a set of brain regions that are active during the process of thinking about other people's goals, thoughts, and feelings. This network appears to be processing social information and priming people for navigating their social lives. "In essence, our brains are built to practice thinking about the social world and our place in it" (Lieberman, 2013, p. 22). Furthermore, studies suggest that such findings have implications in the field of education. For example, research conducted in the 1980s found that when content was read from a social cognitive perspective, memory formation was enhanced (Lieberman, 2012). A more recent conceptual replication of these studies on this social encoding advantage using functional magnetic resonance imaging (fMRI) showed increased activation of a brain region associated with the mentalizing network, and not some regions traditionally associated with memory (Mitchell, Macrae, & Banaji, 2004). These and other studies suggest that learning outcomes might be improved by supporting the use of the mentalizing network (Lieberman, 2012).

In my work with teachers and teacher leaders, a focus is on providing a social context for applying potential implications of these findings by encouraging collaborative learning by teachers through lesson study, observing other teachers applying strategies in their classrooms, giving and receiving feedback, and providing colleagues social support and encouragement as they implement new educational approaches. As Immordino-Yang notes in the Foreword of *Smarter Teacher Leadership:*

> Teaching and learning are inherently social activities, but too often school culture and teachers' training and expectations leave teachers working in a social vacuum. Yet multiple sources of evidence from education sciences, psychology, anthropology, and social neuroscience underscore the fundamental importance of collaboration in all socially oriented realms of work, especially in education. (p. ix)

Teacher leadership and purposeful collaboration: Contribution to the school and student learning (see Chapter 6, pp. 95–107). After his review of more than 900 meta-analyses on factors that influence student achievement, Hattie (2015) concluded:

> …the greatest influence on student progression in learning is having highly expert, inspired and passionate teachers and school leaders working together to maximise the effect of their teaching on all students in their care. There is a major role for school leaders: to harness the expertise in their schools and to lead successful transformations. There is also a role for the system: to provide the support, time and resources for this to happen. Putting all three of these (teachers, leaders, system) together gets at the heart of collaborative expertise. (p. 2)

Several studies support the potential positive impact of key aspects of teacher leadership and purposeful collaboration.

- When leadership is shared among administrators and teachers, there are better working relationships, and higher levels of student learning than are achieved through a top-down leadership approach (Louis et al., 2010).
- A key to improving student achievement is the implementation of new and more effective teaching strategies. Interventions that include the use of collaborative processes such as coaching by skilled teacher leaders have the potential to achieve higher levels of classroom implementation. For example, a meta-analysis by Joyce and Showers (2002) indicated that after interventions in a training setting where theory was shared and discussed, strategies demonstrated and then practiced with feedback given, the resulting classroom use of new strategies was 5%. When high-quality, on-the-job coaching was added, the use of new strategies was 95%.
- When teachers have opportunities to learn and plan together, there can be enhanced job satisfaction, and a more positive, productive, and energizing school climate can be developed. This can lead to improved retention and teacher morale, which in turn can enhance student achievement by keeping experienced, effective teachers in the classroom. In a survey, educators cited supportive relationships with colleagues as a major positive influence on their careers. "The teachers commented that their fellow teachers helped them experience a sense of belonging, ownership, and satisfaction in their jobs, even when district mandates and bureaucratic pressures were mounting" (Waddell, 2010, p. 76).
- The majority of teachers turn to their colleagues when they seek ideas for improving their practice. In a survey by the Center for Teaching Quality, more than two out of three respondents said they rely on fellow teachers more than any other source for

support and sources of information about their professional practice (Berry, Daughtrey, & Wieder, 2009, p.4). This finding provides further evidence of the potential benefit of teacher leaders contributing to professional learning communities in ways that support the improved teaching practice.

- Effective leadership supports professional community where teachers collaborate to improve their practice and increase student learning. Such a community is a strong predictor of instructional practices linked to increased student achievement (Louis et al., 2010). For example, an analysis of more than a decade of matched teacher and student achievement data found that peer interaction within small groups of teachers was a strong predictor of higher student achievement in reading and math (Jackson & Bruegmann, 2009).
- Opportunities for teachers to collaborate through a professional community can help reduce the socioeconomic achievement gap. For example, a study by University of North Carolina researchers indicates that disadvantaged students make the greatest gains when their school districts adopt active professional learning communities for teachers (Moller et al., 2013).

In sum, as is noted in *Smarter Teacher Leadership*:

> …shared leadership and purposeful collaboration support gains in student achievement because these interactions are connected "to the way in which teachers organize themselves into professional communities, to reflective discussions about instruction, and to a sense of collective responsibility for student learning" (Louis et al., 2010, p. 51). As teachers discover the gains that are possible—for their students, for their schools, and for their own professional practice—when they capitalize on leadership opportunities, they are more likely to take on both formal and informal roles and exert their influence to support improvements in learning and teaching, to enhance school culture, to strengthen bonds with the community, and to get involved in policy decisions. (p. 13)

Structures

In *Smarter Teacher Leadership*, I introduce the POWER framework to emphasize the following elements for supporting purposeful collaboration (p. 4):

Plasticity (see Chapter 2, pp. 25–42)—understanding that at all ages individuals have the capacity to learn new skills and create changes in the structure and function of their brains.

At every stage of a teacher's career, there is potential to improve their skills as teachers and teacher leaders.

Opportunity (see Chapter 3, pp. 43–62)—recognizing and taking advantage of opportunities for supporting collaboration among teachers and administrators. Educators working together have greater potential for improving their professional practice than those teaching in isolation.

Work (see Chapter 4, pp. 63–80)—focusing on the development of teachers' metacognitive and cognitive skills that help them work smarter and develop higher levels of instructional expertise. Teachers working with colleagues on high-yield, peer coaching activities, such as reflecting on the impact of their current practice, conducting classroom research, sharing teaching strategies, giving and receiving feedback, and developing assessments, can positively impact teaching and student learning.

Encouragement (see Chapter 5, pp. 81–94)—supporting colleagues as they learn and implement new teaching practices and measure their impact. This process of continually improving one's practice can be daunting for novice and veteran teachers alike. The encouragement of colleagues and leaders is an important factor in supporting the motivation to continue such efforts.

Results (see Chapter 6, pp. 95–107)—sharing outcomes from studies of education systems around the world that support purposeful collaboration of teachers and leaders and show promise for improving teaching and learning.

Strategies

In *Smarter Teacher Leadership*, I advance a process for encouraging educators to take steps toward supporting colleagues beyond their own classrooms through a Spectrum of Teacher Leadership activities which include elements of peer coaching, defined as a "process through which two or more professional colleagues work together to reflect on current practices; expand, refine, and build new skills; share ideas; teach one another; conduct classroom research; or solve problems in the workplace" (Robbins, 1991). The Spectrum of Teacher Leadership includes the following:

1. Engage in and share research on enhancing pedagogy.
2. Support and learn with new and pre-service teachers.

3. Lead professional development.
4. Take on formal roles to support effective teaching.
5. Present at the school and district levels and for professional associations.
6. Participate in effective peer reviews.
7. Engage parents in their children's academic endeavors.
8. Advocate for policies and initiatives that support improvements in teaching and learning.
9. Lead alongside administrators (Robbins, 1991, pp. 14-23).

Support System

In my review of educational systems around the world, it became clear that the top-performing nations and states focus on developing coherent systems for supporting the process of continuously improving teaching practice. While each system is different, there is a common focus on providing resources, time, and opportunities for the purposeful collaboration of educators and administrators **(see Chapter 6, pp. 95–107).**

Reference listing:

Conyers, M. A., & Wilson, D. L. (2016). *Smarter teacher leadership: Neuroscience and the power of purposeful collaboration*. New York, NY: Teachers College Press.

These four texts have been recognized by university peers as presenting an original approach to improving teaching practice through the application of transdisciplinary streams of research. For example, in a review of *Five Big Ideas for Effective Teaching*, Deborah Schussler with the Department of Education and Counseling at Villanova University, noted, "This is an interdisciplinary book like no other currently in publication. The bridge to practice is articulated clearly, setting the stage for a new paradigm in teacher education and how we consider learning." Additionally, the influence of these texts reaches beyond the initial readership of the books since key concepts have been shared in presentations at leading research and practice conferences and in key publications focused on research-based practice (Conyers & Wilson, 2015b; Wilson & Conyers, 2014; Wilson, Conyers, & Rose, 2015).

Section 4: Conclusion

The persistent gap between the science of learning and the practice of teaching contributes to a situation around the world where many students, particularly those from low-income and minority backgrounds are not achieving their academic potential and are therefore less equipped to thrive in the global knowledge economy. The four texts that accompany this commentary aim to bridge this gap by applying a synergy of two original conceptual frameworks that have been researched, developed, and implemented over almost two decades with more than 100,000 educators through professional development and with 2,500 in graduate programmes with evidence of positive impact on teaching practice and student learning.

The first framework connects implications of education, mind, and selected brain research on how people learn to the practice of teaching by encompassing an understanding of (1) malleable intelligence, (2) high expectations for student learning, (3) deliberate practice, (4) a growth mindset, (5) brain plasticity, (6) regular physical activity, and (7) positive affect, all of which can support (8) teaching for the development of metacognitive and cognitive skills that can increase student learning. The second, grounded in implementation science and practice-based research, is designed to support changes in practice. The components are a Solutions Focus, Science, Structure, Strategies, and Support System. The texts, which uniquely incorporate research, theory, and examples of practical strategies being applied in real-world settings, have received positive peer reviews and are reaching a broad range of university faculty, researchers, teachers, and other educational stakeholders. As noted, the influence of these texts reaches beyond the initial readership through conference presentations and articles.

Several limitations apply to the work featured in this commentary and the accompanying texts:

1. The impact studies referenced herein found that teachers applying the framework for teaching, which is similar to that shared in these texts, perceived that they had become more effective teachers, and many examples of changes in practice were

identified. The data were based on teachers' self-reports. In the ethnographic study (Germuth, 2012b), there was evidence of improved student learning but this was limited to a small number of teachers through an ethnographic study. Further research is required to assess the wider impact of this approach.

2. The model for supporting changes in practice connects to emerging research from the field of implementation science and, in the author's experience, has supported observed changes in practice; to date, these observations have received limited external feedback and peer review.
3. The texts shared with this commentary have received positive feedback from peers at universities, have been adopted for use in university programmes, and have begun to be referenced in other texts. One of the texts was ranked as the no. 1 best seller in cognitive psychology on the publisher's list. Key concepts from the texts have also been published in leading education publications focused on practice. However, further analysis is required over time to assess impact more comprehensively.
4. Although positive impact on teaching practice has been noted in terms of individual teachers and small teams of colleagues, it remains rare for school districts to provide the support systems for teachers to work together and to experience high-quality coaching that can sustain changes in practice.

After publishing the fourth book submitted with this thesis, it became clear from feedback received from peers, programme graduates, and teacher educators that a specific resource for supporting the implementation of the process of teaching with and for metacognition was needed. My coauthor and I therefore researched and wrote *Teaching Students to Drive Their Brains: Metacognitive Strategies, Activities, and Lesson Ideas* (Wilson & Conyers, 2016). A follow-up book, *Positive Mindsets for Students from Poverty*, is in the development stage. These two books both flow from the frameworks described in Figure 1 and Figure 2.

The focus of this thesis is on improving teaching practice by applying conceptual frameworks and strategies based on transdisciplinary fields of research including education, mind, and selected brain research. It does not address broader aspects of

teaching practice such as teacher content knowledge, classroom management, educational technology, and the effects of smaller classrooms and schools on student achievement. These and many other topics are covered in most teacher education programmes. The focus of my work adds greater weight to the benefits of practice-based knowledge in the context of research on the factors that improve teaching practice and student learning.

Today we stand at a unique point in history where more is known about how people learn and how to improve the practice of teaching than ever before. At the same time emerging implementation research points the way for approaches that can support changes in practice. By applying a synergy of conceptual frameworks that bring these themes together, there is an unprecedented opportunity for developing educational systems where teachers can apply current knowledge and work together to help all students achieve more of their academic potential.

Appendix A: Confirmation of Relative Contribution to Coauthored Works

(Note: The book *Smarter Teacher Leadership* has also been submitted as part of this thesis. The title of the book *Teaching for Metacognition* was changed to *Teaching Students to Drive Their Brains).*

January 16, 2015

Dr. Franz Buscha
PhD Programme Director
Principal Research Fellow, Economics and Quantitative Methods
Westminster Business School, University of Westminster
35 Marylebone Road, London, NW1 5LS

Dear Dr. Buscha:

Marcus Conyers is applying to the PhD by Published Work programme at the University of Westminster. In 1998 Marcus completed the research and development of the original BrainSMART model for aligning instruction with mind, brain, and education research on how students learn. I joined the group in 1999. Since then, we have cowritten a series of academic publications and developed graduate degree programs building on this work. Historically I have been listed as first author as I have my PhD, even though we usually contribute to the research and writing equally. I wanted to confirm the percentage of work I have contributed as coauthor to the following titles:

Submitted with Marcus Conyers' Application

Conyers, M. A., & Wilson, D. L. (In press). *Positively smarter: Using educational neuroscience to increase happiness, achievement, and well-being.* Hoboken, NJ: Wiley. (Scheduled for July 2015 release; 30% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2013). *Five big ideas for effective teaching: Connecting mind, brain, and education research to classroom practice.* New York, NY: Teachers College Press. (50% contribution by Wilson.)

Wilson, D. L. & Conyers, M. A. (2013). *Flourishing in the first five years: Connecting implications from mind, brain, and education research to the development of young children.* Lanham, MD: Rowman & Littlefield Education. (50% contribution by Wilson.)

Other Selected Publications

Conyers, M. A., & Wilson, D. L. (In development). *Innovating minds: Keys to learning and teaching creative thinking skills.* (Under contract with Wiley for scheduled August 2016 release; 20% contribution by Wilson.)

Conyers, M. A., & Wilson, D. L. (In press). *Mind, brain, and teacher leadership: Leveraging the POWER of purposeful collaboration.* New York, NY: Teachers College Press. 2015; 30% contribution by Wilson.) Title changed to *Smarter Teacher Leadership*

Conyers, M. A., & Wilson, D. L. (In press). Smart moves: Powering up the brain with physical activity. *Kappan.* (20% contribution by Wilson.)

Conyers, M. A., & Wilson, D. L. (In press). *Effective teaching, successful students* (Fischler School of Education at Nova Southeastern University Series, 2nd ed.) [Kindle version]. Orlando, FL: BrainSMART. (Scheduled for March 2015 release; 30% contribution by Wilson.)

Conyers, M. A., & Wilson, D. L. (2009). *Introduction to BrainSMART HealthWise* (Fischler School of Education at Nova Southeastern University Series, 2nd ed.). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

Conyers, M. A., & Wilson, D. L. (2006). *BrainSMART in the house* (Fischler School of Education at Nova Southeastern University Series, 2nd ed.). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

Conyers, M. A., & Wilson, D. L. (2000). *BrainSMART 60 strategies for boosting test scores* (Fischler School of Education at Nova Southeastern University Series). Orlando, FL: BrainSMART. (20% contribution by Wilson.)

Wilson, D. L. & Conyers, M. A. (In development). *Teaching for metacognition: Core strategies to increase student achievement.* Book proposal submitted to Association for Supervision and Curriculum Development (ASCD), November 2014. (Anticipated 50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2014, October). "The boss of my brain." *Educational Leadership, 72*(2). Retrieved from http://www.ascd.org/publications/educational-leadership/oct14/vol72/num02/%C2%A3The-Boss-of-My-Brain%C2%A3.aspx (50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2013, December). Understanding and mastering complexity: The five new cognitive complexities that teachers confront. *Information Age Education Newsletter, 127.* Retrieved from http://i-a-e.org/newsletters/IAE-Newsletter-2013-127.html (50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2011). *BrainSMART 60 strategies for increasing student learning* (Fischler School of Education at Nova Southeastern University Series, 4th ed.). Orlando, FL: BrainSMART. (20% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2011). *Thinking for results: Strategies for increasing student achievement by as much as 30 percent* (Fischler School of Education at Nova Southeastern University Series, 4th ed.). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2010). *Administrator's workbook for increasing student achievement: BrainSMART strategies for leading and teaching* (Fischler School of Education at Nova Southeastern University Series). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2010). *Courageous learners: Increasing student achievement in diverse learning communities* (Fischler School of Education at Nova

Southeastern University Series, 3rd ed.). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

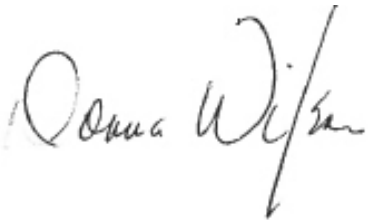
Wilson, D. L., & Conyers, M. A. (2010). *Wiring the brain to read: Brain-based differentiated reading instruction* (Fischler School of Education at Nova Southeastern University Series). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2010). *Wiring the brain to read: Higher-order thinking for reading* (Fischler School of Education at Nova Southeastern University Series). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2009). *Wiring the brain to read: Beginning reading preK–grade 3* (Fischler School of Education at Nova Southeastern University Series). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2005). *Drive your brain: The road to reading success packet* (Fischler School of Education at Nova Southeastern University Series). Orlando, FL: BrainSMART. (50% contribution by Wilson.)

Wilson, D. L., & Conyers, M. A. (2005). *Thinking for reading packet* (Fischler School of Education at Nova Southeastern University Series). Orlando, FL: BrainSMART. (50% contribution by Wilson.)



Donna Wilson, Ph.D.

Appendix B: Peer Reviews of Featured Works

Five Big Ideas for Effective Teaching: Connecting Mind, Brain, and Education Research to Classroom Practice, by Donna Wilson and Marcus Conyers

Peer Reviews/Peer Feedback

- The proposal for this book was subjected to a peer review process and was reviewed and approved by the editorial board of Teachers College Press.
- The publisher asked Robert Calfee, an emeritus professor at Stanford University, to review the book and to consider the opportunity for writing a foreword. In his earlier text, *Handbook of Educational Psychology II,* Calfee identifies research on plasticity and other aspects of brain studies as one of four "really important problems" that we must learn more about in education and apply to classroom practice (2006, p. 35). His foreword, which included this assessment of the text:

  > This book does feature recent advances in brain research, but the "five big ideas" build on more than a century of research across a broad spectrum of disciplines—neurologists and psychologists, cognitivists and computer scientists, researchers and practitioners. The title promises ideas for effective teaching, and the book delivers on this promise in clear, compelling, and believable prose. This is a book for educators, for policymakers, for parents, and even for presidents. (p. ix)

- The text was forwarded to peers in the MBE field, who supplied useful feedback in line with the intent of the publication. Reviewer comments included in the book:
  - "This book is easy to read, understand, and use to apply what we know about learning in the brain and translate that knowledge into educational practice."
    —Daniel C. Miller, Texas Woman's University
  - "One of the best books on neuroscience and education. Given the new core standards, topics in the book are just what teachers need."
    —Debby Zambo, Arizona State University

- "Brings together many disparate lines of inquiry into a 'big idea' framework that helps professionals consume and apply critical funds of knowledge efficiently. It could be used as required reading for a pre-service teacher education course."
  —Tanner LaBaron Wallace, University of Pittsburgh
- "This book will be a welcome and important supplement to any traditional educational psychology text."
  —Linda Rittner, University of Central Oklahoma
- "In their most interesting and instructive book, the authors appear to me as guides leading readers on a fascinating journey of discovery."
  —Reuven Feuerstein, Cognitive Psychologist, International Center for the Enhancement of Learning Potential
- "The theme woven throughout *Five Big Ideas* cannot be overstated: ALL children can learn. This book is a must-read for everyone who interacts with children and young adults!"
  —Martha H. Hopkins, School of Teaching, Learning, and Leadership, University of Central Florida
- "This promising paradigm that applies theory to classroom challenges offers hope for our schools struggling with outdated practices."
  —Ruth V. Burgess, Emeritus Professor, School of Teacher Education, Missouri State University
- "Every school of education should make this book mandatory reading and Deans should hop on-board and make it a required roundtable text for their faculties."
  —Douglas Stewart, O'More College
- "This text provides a treatise to move teachers and their students from an educational paradigm preparing them for a world rapidly ceasing to exist to the flexible thinking for adaptation to whatever the future may hold."
  —Marjorie S. Anderson, Coordinator of Field Experience, Director of Secondary Education Program, Cumberland University

- "The five big ideas presented in this book summarize current research findings that are important for all effective educators, teacher educators, administrators, policymakers, and parents."
  —Brett D. Jones, Educational Psychology, Virginia Tech
- "I found this book uplifting and inspiring. It integrates established research and theory with myth-busting and insightful presentation of the latest research."
  —Susan M. Benner, Associate Dean of Professional Licensure, College of Education, Health, and Human Services, University of Tennessee, Knoxville
- "An excellent volume that has multiple applications for classroom teachers, researchers, preservice teachers, and policymakers."
  —David S. Martin, Professor/Dean Emeritus, Gallaudet University
- "This text is a wonderful choice for student teaching seminars or PLCs in schools. If your goal is to establish a culture of continuous improvement, this book is for you."
  —Lisa J. Lucas, West Chester University, Educator, Coach and Consultant
- "I particularly appreciated the emphasis on providing workable ideas and strategies for classroom practitioners. I look forward to sharing this book with my students."
  —Keith Nikolaus, Educational Leadership, Lipscomb University
- "This inspirational book merges brain science and pedagogy by generating a powerful congruity between the science of learning and the art of teaching through strategies that have a profound impact on student learning."
  —Reem Kobrsi, President, International Educational Organization
- "As a classroom teacher, I can say that these five interconnected big ideas have enhanced the way I teach and the way my students take charge of their own learning potential."
  —Kelly D. Rose, Classroom Teacher, Bristol, Virginia

- "The concepts in this book have helped me become a more effective teacher. My students have become metacognitive learners who know that learning changes their brains, and their motivation has soared!"
  —Diane Dahl, Classroom Teacher and edublogger, *For the Love of Teaching*

- The text was reviewed in peer-reviewed journals (Craver, 2014.; Nance, 2013).

Impact

- Since its launch in 2013, the book has been adopted as required reading in education courses at universities, including the University of Central Oklahoma and Illinois State University.
- Following the book's use as required reading in a master's course at Illinois State University, the graduates wrote chapters in a new book, *Brain Science for Principals: What School Leaders Need to Know,* edited by their professor, Linda L. Lyman (Rowman & Littlefield, 2016).
- It went into a second printing in 2015.
- The book was selected as a *UK Times* Higher Education recommended text in 2013. http://store.tcpress.com/0807754250.shtml
- Key concepts explored in this book formed the basis of peer-reviewed presentations at conferences of the American Educational Research Association (AERA; Wilson, Conyers, & Buday, 2013), the International Association of Cognitive Education and Psychology (IACEP; Wilson & Conyers, 2013a), and the Inaugural Conference on Implementation Science at Cambridge University (Wilson & Conyers, 2014).

Critical Reflection

The critical feedback from peers about this text suggests that there is value in this work in terms of translating implications from education, mind, and selected brain research into a framework for improving teaching practice for K-12 educators. However, the scope of the text was ambitious, and more in-depth discussions to important areas seemed to be in order. Thus, additional books might benefit the field, including, first and foremost, a text supporting faculty of early childhood educators who work with children ages 0–5. Infants and young children are in a critical time for social, cognitive, and emotional development.

In particular, emerging research suggested that vital self-regulation skills and the foundations of metacognitive and cognitive skills could be taught at a young age.

Flourishing in the First Five Years: Connecting Implications from Mind, Brain, and Education Research to the Development of Young Children*,* by Donna Wilson and Marcus Conyers

Peer Reviews of the Text

- Debby Zambo, professor with the Division of Leadership and Innovation with Arizona State University and coauthor of *Early Childhood and Neuroscience: Links to Development and Learning,* wrote that this book "crosses the research, theory, and practice divide because it supplies seminal and current research from neuroscience at an understandable level and links it to everyday strategies that teachers, parents, and caregivers can use to make a difference in children's lives."
- Another peer who reviewed the text, Marcia Stewart, a professor of education at Lipscomb University with expertise in early childhood education, called this text "an encouraging and optimistic book that offers hope for future generations of learners." She went on to write that "knowledge of the critical importance of the first five years for optimal development has been acknowledged for decades, but Donna Wilson and Marcus Conyers take this salient fact to another level with their explanations of the malleability of the brain during this time and with specific ideas of how to maximize and unlock the potential within each child. The authors provide creative and practical strategies that can easily be implemented by parents, teachers, and other caregivers."
    - "Wilson and Conyers put all the pertinent research together with high-quality early childhood practices to create a guide for parents, teachers, and educators everywhere. The storytelling lessons on 'hard-to-teach' topics become real and relevant to children. This book is an excellent summary of what a young teacher needs to get started as well as an excellent guide for the veteran teacher who is always learning."

—Sarah Sprinkel, director of elementary education/Florida services for Florida virtual school and city commissioner, Winter Park, Florida

- "*Flourishing in the First Five Years* is an enjoyable book to read, and I think it would be a valuable tool for any parent or educator who is interested in exploring the connection between current brain research and child development. The authors' writing style and use of real scenarios for applying strategies help make these concepts understandable."
  —Karen Sinclair, director, First Congregational Church weekday preschool and kindergarten, Winter Park, Florida
- "The first five years are the most sensitive and impressionable years, and *Flourishing the First Five Years* can help parents and educators make a head start. It is a must-read!"
  —Regina Cabadaidis, preschool/kindergarten teacher at S. D. Spady Elementary School, Delray Beach, Florida

Impact

The text is a part of the coursework in the Brain-Based Teaching programme at NSU. Research and development for this work had been shared at conferences such as the Second Annual Roundtable hosted by the Center on Enhancing Early Learning Outcomes (CEELO) (Wilson, 2014).

Positively Smarter: Science and Strategies for Increasing Happiness, Achievement, and Well-Being, by Marcus Conyers and Donna Wilson

Peer Reviews of the Text

- "A fine book that authoritatively communicates the increasing scientific base to empower educators with solid evidence to improve their professional practice and enhance their own well-being. Former works appropriately had to add *perhaps* and *maybe* to much of the text."
  —Robert Sylwester, EdD, University of Oregon
- "This book is a captivating read that contains definitive and clear steps to guide the reader on the path to becoming 'positively smarter.'

—Carol Mikulka, MD, Psychiatrist, Founder and President, Walden School

- More than a typical "self-help" book, *Positively Smarter* provides real, attainable direction for every reader!"
  —Lisa Holder Lohmann, EdD, University of Central Oklahoma
- "*Positively Smarter* is a wonderful resource and thoughtful compilation of ground-breaking research and discoveries into the complete phenomenon of personal success. The integration of scientific data, personal vignettes, and practical suggestions for making positive changes in one's life drives home the idea that with effort, perseverance, hope, and setting realistic goals, we can all succeed."
  "*Positively Smarter* supports parents as they seek strategies that will support their children in an environment that is changing at record speed."
  —Kelly Rose, EdD, The Out-of-Door Academy

Impact

- The text became the no. 1 best seller in Cognitive Psychology with Wiley Blackwell worldwide (the publisher's main focus is on texts for university courses).
- The text is included in readings for teaching graduate degree programmes with Nova Southeastern University.
- A research study is proceeding with Rollins College centered on the research and strategies from this text.
- Work from this text has been presented at other institutions of higher education and at the community college and high school level.
- Key concepts have been published in educational journals, including *Phi Delta Kappan* (Conyers & Wilson, 2015b).

Smarter Teacher Leadership: Neuroscience and the Power of Purposeful Collaboration, by Marcus Conyers and Donna Wilson

Peer Reviews of the Text

- The proposal for this book was subjected to a peer review process and was reviewed and approved by the editorial board of Teachers College Press.

- Mary Helen Immordino-Yang, EdD, President-Elect of the International Mind, Brain & Education Society and Associate Professor at the Brain and Creativity Institute and Rossier School of Education, University of Southern California, reviewed this book and authored it's Foreword, in which she wrote: "Marcus Conyers and Donna Wilson have produced a clear, practical guide to improving teaching through strategic collaboration. Given the inherently social nature of the human mind and the fundamentally social work of teaching, this book is a useful addition to any ambitious teacher's library."
- **Other peer reviewers offered these comments:**
    - *"Smarter Teacher Leadership* is an excellent and really useful book for both aspiring and serving leaders. The power model of leadership is developed and is a welcome shift towards purposeful collaboration among teams of people. In an age of dominance of systems and structures this is a refreshing approach."

      —Elaine Wilson**,** University of Cambridge
    - "Using neuroplasticity and metacognition as key vehicles, Marcus Conyers and Donna Wilson elevate the concept of teacher leadership to a new level of understanding and significance. Their work has a research-based authority, and a deep sensitivity to teachers as professionals, that is both rare and admirable."

      —Frank Crowther**,** emeritus professor, University of Southern Queensland
    - "Teaching and learning are inherently social activities, but too often school culture and teachers' training and expectations leave them working in a social vacuum. Conyers and Wilson have produced a clear, practical guide to improving teaching through strategic collaboration—a useful addition to the ambitious teacher's library!"

      —Mary Helen Immordino-Yang**,** associate professor of Education, Psychology and Neuroscience, University of Southern California
    - "I love this book! This is a perfect text to accompany what we teach in our master's degree in educational leadership. This inspiring and encouraging

book will guide graduates in their new roles as administrators."
—Lisa Lohmann, University of Central Oklahoma

- "Conyers and Wilson provide a POWER-ful resource for tapping teacher leadership within schools to inspire collective intelligence, efficacy, and action that leads to student achievement. Combining research, practical experience, and the voice of teacher leaders, they demonstrate how to leverage collaboration among professionals to transform schools into places of learning for students and adults."
  —Joellen Killion, senior advisor, Learning Forward
- "This book is a must-read for educational leaders who are committed to improving student learning by levering the power of purposeful collaboration. The text combines a strong research base with practical strategies that can be applied immediately."
  —Judith Warden, CEO, Blue Ribbon Schools of Excellence
- "An excellent bottom-up collegial focus that provides useful non-technical information about how to insert educationally significant cognitive developments into classroom management, instruction, and assessment."
  —Bob Sylwester, professor emeritus, University of Oregon
- "Breaking the lockdown on student learning—this is the essential guidebook for teacher leaders who remain in the classroom while helping expand collegial knowledge of neuroscience, adult learning and purposeful collaboration."
  —Margaret Ridgeway, Classroom Teacher Leader, Tara High School, Baton Rouge, Louisiana
- "From a principal's perspective there is no truer belief that purposeful collaboration among teachers will lead to improved lessons and thus translates to improved instruction."
  —Priscilla Bourgeois, former principal, Jefferson Community School, Jefferson Parish, Louisiana
- "In another direct example of their work illustrating how mind, brain, and education research impacts our classrooms, Conyers and Wilson have

nailed it once more. *Smarter Teacher Leadership* is clear and straight to the point: Learning never stops, so why should it for teachers? Highlighting cultural paradigm shifts geared toward entire academic communities, *Smarter Teacher Leadership* is full of insight to improve teaching and learning at any level."

—Michael Fitzgerald, English teacher, Eagle Academy, Eagle, Idaho

- "We can improve education as we unleash teacher leadership. Marcus Conyers and Donna Wilson have done a tremendous job of collecting the research on the brain, teaching, and leadership that works in a powerful collaborative method that can help us move things forward. Teacher leadership isn't just "nice to have," it is an essential ingredient of effective 21st-century schools where students are engaged and learning. This book will help you get there."

  —Vicki Davis, Westwood Schools, Camilla, Georgia

Appendix C: Research on the Impact of the Graduate Programmes on Teaching Practice

This is an expanded version of content found in Section 1.3.

In order to assess the effectiveness of the NSU graduate degree programmes, I led on the process of evaluating the impact of teachers' graduate studies on their teaching practice. Specific responsibilities for this research included defining objectives for the impact studies; developing the questions that formed the basis of the study; ensuring that the focus of the study remained clearly aligned with the intention of the programme; and ensuring effective internal validity by selecting research methods that combined quantitative analysis via a survey.

The research methods were chosen to gather quantitative and qualitative data about whether and how teachers applied what they learned in the graduate programme to their teaching practice and what impact this new way of teaching had on student learning. Results from both studies—an anonymous survey administered to recent graduates and an ethnographic study consisting of structured interviews with a representative sample of graduates—demonstrate that the programme positively affects the attitudes, beliefs, and practices that teachers bring to the classroom and that teachers credit the programme with helping them increase student engagement and achievement.

Objectives

Two external researchers were engaged to evaluate the impact of the programme by conducting a survey of graduates (Harman & Germuth, 2012) and an ethnographic study (Germuth, 2012b). Each study aimed to answer these key questions:

- How did the experiences graduates had in the mind, brain, and education programme prepare them to be more effective teachers?
- What impact has the mind, brain, and education programme had on the graduates' teaching practice?

Methods

The quantitative portion of this impact study (Harman & Germuth, 2012) consisted of an anonymous survey administered online; teachers received a link to access the survey within three months of graduation. To gain a deeper understanding of teachers' experiences in and reactions to the programme, an ethnographic study was conducted, consisting of focused interviews with eight programme graduates (Germuth, 2012b). A case study approach was used (Stake, 1995; Yin, 1993), informed by Patton's (1990) work on qualitative sampling and Lawrence-Lightfoot and Davis's (1997) work on portraiture methodology. All graduates were asked 14 questions in the same order, and the researcher asked follow-up questions, as needed, to clarify responses. Interviews were conducted over the phone and lasted approximately 45 minutes to one hour.

Data Outcomes

Harman and Germuth (2012) report that 294 graduates earning a master's or educational specialist degree completed the survey, a response rate of 61%. Of these graduates, 254 were working as K-12 teachers when they completed the survey:

- 148 (50%) were teaching elementary (preK through grade 5) students.
- 64 (22%) were teaching middle school students (grades 6-8).
- 42 (14%) were teaching in high schools (grades 9-12).

The eight interviews conducted for the ethnographic study (Germuth, 2012b) were recorded and then written as individual stories consisting of narrative and direct quotations. (The graduates' names were changed in the stories.) The teachers were chosen because they represented a mix of geographic areas, years of experience, subject areas, and school levels; most importantly, they also taught a diverse and challenging range of learners (English as a Second Language students, special education students, and disadvantaged populations in Title I schools).

Results

Although it was not used in research design, results suggest a positive impact on the four levels of the Kirkpatrick Model (Kirkpatrick Partners, 2016) for evaluating training:

Level 1: Reaction—evaluates how participants respond to the training.
Level 2: Learning—measures if they actually learned the material.
Level 3: Behavior—considers if they are using what they learned on the job.
Level 4: Results—evaluates if the training positively impacted the organization.

Specifically, the ethnographic study suggests a change in Behavior and Results as teachers explicitly teach cognitive and metacognitive skills that increased student learning.

Level 1 Reception

- Evidence suggests that respondents were positive about the programme. For example, some 60% opted to respond to the survey which is a relatively high response rate.
- Statements from respondents indicated positive reception to the programme. For example, "My students now have a teacher who has the strategies and tools to help them to think metacognitively and to teach them how to become successful in school and in their personal lives" (Harman & Germuth, 2012, pp. 28).

Level 2 Learning

Participants had successfully completed the coursework and ongoing assessments in the graduate programme, suggesting successful learning of the material. Responses to the survey suggest a positive impact at Levels 2:

- I have added more teaching strategies to my toolbox. (97%)

Level 3 Behavior

Responses suggest a positive impact on Behavior:

- I am using what I learned on a regular basis. (91%)
- I think and reflect more on my teaching practice. (92%)

Level 4 Results

Responses suggest a positive impact on Results:

- More of my students are learning more of the time. (86%)
- I am a more effective teacher. (92%)

However, a major limitation to the survey is that it is based on graduates' perceptions of the impact of the programme. Therefore, it is important to examine the findings of the ethnographic study, which explored more deeply the impact of the programme, including data at the levels of behavior and results as a consequence of changing teaching practice. Specifically, the study addressed the area of explicit instruction on using cognitive and metacognitive skills to improve learning and increase student achievement. Toward those ends, the study notes:

> The graduates reported greater student achievement gains. Six of the seven teachers reported that student achievement, in terms of classroom work and/or test scores, had risen since they had completed their program. All these teachers, regardless of subject, ages taught, or background of teacher and students, credited the degree programs with positively impacting the student learning gains. All teachers further credited the teaching of cognitive and metacognitive skills as a major reason that student achievement went up. (Germuth, 2012b, p. 33)

The ethnographic study offers several indicators of student learning gains. For example, one participant reported "an explosion of growth" in her students' academic achievement in reading over three to four months:

> She believes this is due to particular teaching strategies she has applied in her classroom, such as "thinking stems" where students are required to indicate what they wonder, infer, or think will happen. Students then blog about their thoughts, and a network of educators across the world comments on what students write. Debra noted that her students find this activity meaningful and motivating. It has also produced great readers—of her 23 students, only five are not reading above grade level. In fact, over a three-

> month period, her students made gains of five months in their reading levels, representing gains she had never seen her students make previously. (p. 6)

Another study participant, who taught K-5 students English for Speakers of Other Languages (ESOL), credited the theories and teaching strategies she learned in her graduate studies, at least in part, for her students' academic gains. Test score data provided by the teacher "showed how four second-grade classes receiving supplemental instruction from her improved their reading comprehension skills and writing skills over the course of the year, with virtually every student meeting or exceeding expectations in each category by year's end" (p. 17).

A high school teacher participating in the ethnographic study echoed many of the key principles at the center of the framework taught in the graduate programme, noting that studying the implications of mind, brain, and education research made her a more positive and patient teacher willing to persist in applying a wide range of strategies to help all her students learn. Several teachers in the study spoke of learning gains that resulted when they taught students how and why to wield metacognitive and cognitive strategies within the context of core content lessons.

Overall in the analysis of graduate responses, major findings emerged on the impact of the programmes on their teaching practice:

- Graduates are more metacognitive and positive about their learning and teaching.
- Graduates better understand how students learn and can use this knowledge to improve their teaching practice.
- Graduates' teaching practice and overall student outcomes have improved.

Results from both of these preliminary impact studies by Harman and Germuth (2012) and Germuth (2012b) are consistent with other forms of feedback such as university evaluations, informal feedback from faculty and students, and personal communication with graduates at conferences and social media.

Scholarly Significance

A literature search for impact studies of university degree programmes in mind, brain, and education revealed little, perhaps because Brain-Based Teaching/MBE is an emerging field and few such programmes are offered (Sevier, 2013; Sparks, 2012). The impact studies involving graduates of the NSU programmes suggest that teachers who pursue degrees in this new field can improve both teaching and learning, regardless of subject area, grade level, or student population. Teachers who experienced these programmes, which were intended to develop teachers' instructional practices, perceived that they were better able to reach all their students and that student achievement increased. In particular, the programme's emphasis on understanding the research on how people learn, brain plasticity, expectations, student potential, metacognition, and the appropriate use of cognitive strategies seemed to have a powerful impact on teachers' practice (Germuth, 2012b, p. 2). I have shared results of these studies through peer-reviewed presentations at key research and practitioner conferences. My coauthor has also shared this data at selected conferences (see Appendix D). Results from both of these preliminary impact studies by Harman and Germuth (2012) and Germuth (2012b) align well with more general feedback from students and course lecturers and feedback from other professional development initiatives that informed the writing of the texts included with this critical commentary.

In my decision to reach out to a broader audience with this approach to teacher education, my criteria for selecting publishers included an assessment of their reputation as academic houses and their experience in being among the few with previously published texts in the emerging field of mind, brain, and education. This meant the editorial staff could support a useful peer review process. The publishing houses selected also have good outreach to university faculty in schools of education, a key group we wish to support.

Research Limitations

These studies should be regarded as a preliminary investigation of programme impact. While the quantitative study indicated that the vast majority of programme graduates perceived that they had become more effective teachers, indicating a positive change in

practice as a result of the programmes, these results are based on perceptions and not on other assessments. While the ethnographic study found evidence of change in practice and an increase in student achievement in the classrooms of six of the seven participating teachers (the eighth participant was a parent educator), the scope of the study is too limited for wide application. Further research needs to be conducted.

Appendix D: Selected Peer-Reviewed Presentations at Research and Practice Conferences

I co-developed the following conference presentations and served as the lead presenter sharing findings from the impact studies on the graduate degree programmes based on education, mind, and selected brain research that underpin the books that are part of this thesis:

Wilson, D. L., & Conyers, M. A. (2013a). *Connecting Five Big Ideas from Cognitive, Brain, and Education Research to Teacher Education*. Paper presented at the International Association of Cognitive Education and Psychology, XIVth Biennial International Conference, June 25, Leiden, The Netherlands.

Wilson, D. L., & Conyers, M. A. (2014). *Program Designed with Implementation in Mind: Investigating the Impact of Graduate Studies Focused on Applications of the Emerging Science of Learning*. Paper presented at the Inaugural Conference on Implementation Science, Implementing Implementation Science: The Science of Making Interventions Effective in Real-World Contexts, July 28, University of Cambridge, Cambridge, England.

Wilson, D. L., Conyers, M. A., & Buday, M. (2013). *Exploring the impact of a graduate degree program connecting the implications of mind, brain, and education research to teaching and learning.* Paper presented at the American Educational Research Association Annual Meeting, Education and Poverty: Theory, Research, Policy and Praxis, April 27, San Francisco, CA.

In addition to the above, my coauthor Donna Wilson presented our findings at the conferences referenced below:

Wilson, D. L. (2014). *Research-based ideas for improving the quality of learning and teaching birth through grade three.* Keynote address presented at the Second Annual Roundtable, Center on Enhancing Early Learning Outcomes (CEELO), June 4-6, Minneapolis, MN.

Wilson, D. L., & Buday, M. (2012). *Strengthening teacher effectiveness with implications from neuroeducation: A qualitative study of K-12 teachers focusing on higher needs students.*

Paper presented at-American Association of Colleges for Teacher Education Annual "Imagine the Impact: Providing a Learning Journey for All" Meeting, Feb. 18 Chicago, Illinois.

List of Abbreviations

AACTE American Association of Colleges for Teacher Education

AERA American Educational Research Association

AEIOU Representation of young children's learning cycle: attention, exploration, inquiry, order, and understanding and use (introduced in *Flourishing in the First Five Years*)

ASCD Association for Supervision and Curriculum Development

CDC U.S. Centers for Disease Control and Prevention

CIA Model Metacognitive strategy involving control, influence, and acknowledgment (introduced in *Positively Smarter*)

fMRI functional magnetic imaging

IACEP International Association of Cognitive Education and Psychology

MBE Mind, Brain, and Education

NCATE National Council for Accreditation of Teacher Education

NSU Nova Southeastern University

PEAK Metacognitive strategy involving the steps of plan, execute, assess, and keep improving (introduced in *Positively Smarter*)

PET positron emission tomography

POWER Framework including potential, opportunity, work, encouragement, and results (introduced in *Smarter Teacher Leadership*)

Glossary

Achievement goal orientation theory A theory that explains motivation by differentiating between two types of goals that individuals might pursue—mastery goals and performance goals.

Action research A term coined by social psychologist Kurt Lewin to describe a circular process of planning, execution, and reflection.

AEIOU Learning Cycle Representation of the learning cycle in five stages: attention, exploration, inquiry, order, and understanding and use; this cycle occurs as the human brain becomes aware of new knowledge, processes the concepts and information, and then applies the new knowledge and skills.

Aerobic exercise Form of exercise involving low to moderately intense activities performed for extended periods of time with the aim of improving cardiovascular health, which contributes to enhanced physical and cognitive functioning.

Angiogenesis Development of new blood vessels, which enhances flow of oxygen and nutrients to the body and brain.

Appropriate courage Cognitive ability characterized by the willingness to commit to new experiences that are necessary to achieve one's aims.

Attention cycle The periods in which the brain shifts in and out of high attention. The highest level of attention in this cycle is typically at the beginning and end, referred to as *primacy* and *recency*.

Attention deficit hyperactivity disorder (ADHD) A neurobehavioral disorder characterized by pervasive inattention, hyperactivity, and impulsivity.

Attention The ability to focus on a specific object, task, or piece of information without being distracted by extraneous stimuli. There are two forms of attention: *bottom-up*, which is activated by the stimuli around you, and *top-down*, which is the deliberate focus of your brain on a specific task.

Attribution theory A theory of motivation, developed by Bernard Weiner, that focuses on how people explain their own behavior, particularly in regard to achievement—that is, whether success is determined by effort or ability.

Autism A neural development disorder characterized by impairment in communication and in developing social relationships. The term *autism spectrum disorders* (ASD) encompasses a range of disorders with such characteristics.

Axon Long, unbranched fiber on a neuron that carries nerve impulses away from the cell to the next cell; see also *neuron*, *dendrite,* and *synapse.*

BDNF Brain-derived neurotrophic factor, a protein secreted in the brain that supports neuronal and synaptic growth; exercise has been found to increase production of this chemical, which may enhance learning.

Body-Brain System Refers to the way the body and brain work together to accomplish learning; primary supports for optimal functioning of the Body-Brain System include healthy nutrition, regular physical activity, adequate sleep, and attention to the role of positive emotions in supporting learning.

Brain hemispheres Right and left sides of the brain.

Brain imaging The process of using technology, such as functional magnetic resonance imaging (fMRI), to measure and analyze the structure and function of the brain.

Brain plasticity The brain's capability to adapt to changes and new information by forming new neural connections throughout life; also known as *neuroplasticity*.

BrainSMART An approach to connecting education, mind, and brain research to teaching practice developed by Marcus Conyers. This approach is studied through a series of graduate degree programmes with majors in Brain-Based Teaching (BrainSMART Programmes) with Nova Southeastern University. Key elements are also studied through professional development.

Brainstem One of the three major parts of the brain, which receives sensory input and monitors vital functions such as the heartbeat, body temperature, and digestion.

Broca's area An area in the brain's frontal lobe that is associated with the production of speech and other linguistic functions.

Central nervous system The part of the body that encompasses the brain and spinal cord.

Cerebellum Cauliflower-shaped structure below the brain's occipital lobe; current research suggests that this part of the brain coordinates muscle movement and is linked to cognition, novelty, and emotions.

Cerebral cortex See *neocortex*.

Cerebrum The largest of the three major parts of the brain; it is composed of the left and right hemispheres and controls sensory interpretation, thinking, and memory.

Chromosome disorders Disorders characterized by an abnormal number of chromosomes, either more or fewer than the typical 46; an example is Down syndrome, wherein children are born with an extra copy of chromosome 21.

CIA Model Proactive process for maintaining a positive and productive outlook by focusing on what we can *control*, recognizing the factors that *influence* our thoughts and actions, and acknowledging that some things are beyond our *control*.

Clear intent Cognitive ability to develop and maintain a clear sense of one's intention in any given situation.

Code-related skills The ability to decode and encode text as required for reading and writing.

Cognitive assets Thinking skills and strategies that can be taught and learned to improve problem solving, creative endeavors, and learning in school and in life.

Cognitive development Construction of thought processes, including perception, problem solving, decision making, and memory.

Cognitive flexibility Capacity to accurately assess situations and adjust one's thoughts and actions appropriately, which entails being open to new ideas and the possibility that there may be better ways to do things.

Collaborative learning An approach to education, training and development, that involves groups of learners working together to solve problems, create novel solutions, improve processes, and complete important tasks.

Collaborative expertise The combined knowledge, skills, and application of experience of a group of individuals working together toward a common aim.

Common Core State Standards Academic performance standards in language arts and mathematics adopted in many U.S. states with the aim to provide educators with targets for helping students progress in key areas of learning.

Comparing, contrasting, classifying, and making connections Cognitive ability to notice similarities and differences; group and distinguish between information to suit one's purpose; and link information to create deeper meaning and facilitate greater understanding.

Corpus callosum Bridge of nerve fibers connecting the left and right cerebral hemispheres and facilitating communication between them.

Cortisol Steroid hormone that is released as the brain responds to stressful situations.

Critical period See *sensitive period*.

Critical thinking Ability to think analytically or reflectively to determine a course of action or to formulate a set of beliefs.

Crystallized intelligence An individual's "network of knowing," or accumulated knowledge and skills.

Default network A set of brain regions that become more active when the mind is at rest from other cognitive tasks.

Deliberate practice Term used by psychologist K. Anders Ericsson to describe a commitment to hard work and regular self-assessment over a sustained period of time to develop the knowledge and skills required in acquiring expertise in one's chosen field.

Dendrite Branched extension from the cell body of a neuron that receives impulses from nearby neurons through synaptic contacts; see also *neuron*, *axon,* and *synapse.*

DNA Deoxyribonucleic acid, the main component of living tissue that contains the genetic code responsible for inheritance and transmission of chromosomes and genes.

Down syndrome A chromosomal disorder caused by the presence of an extra copy of chromosome 21.

Effective expression Cognitive ability to Express oneself thoughtfully based on appropriate exploration and planning on a topic or problem.

Emerging literacy Period during which a child is developing the abilities required to read and write.

Entity view A view of intelligence, suggested by Carol Dweck, that treats intelligence as fixed and stable.

Executive function Set of cognitive processes that occur in the brain to organize thoughts and activities, set priorities, manage time, and accomplish goals; related to *self-control* and *working memory*.

Experience-dependent synaptogenesis Process through which the brain creates new synapses based on one's unique experiences in school, at home, and throughout life.

Experience-expectant synaptogenesis Process through which the brain creates new synapses based on experiences that are common to virtually all humans and important for development, such as walking and talking.

Exuberant synaptogenesis Periods of rapid development, for example, during infancy; this period usually peaks around 10 months of age; see also *synaptogenesis*.

Fetal alcohol syndrome Pattern of congenital abnormalities in a child caused by consumption of alcohol by the pregnant mother. The term *fetal alcohol spectrum disorders (FASD)* describes a range of disorders that may encompass a variety of physical, mental, and emotional impairments.

Finishing power Cognitive ability to sustain one's focus on a task over a period of time or in the face of challenges in order to complete it.

Fixed mindset Similar to the entity view of intelligence, the fixed mindset identified by Carol Dweck describes a viewpoint that assumes individuals cannot increase their intelligence.

Flourish To grow luxuriantly, to achieve success.

Flow As defined by psychologist Mihalyi Csikszentmihalyi, the feeling of being completely immersed in a task and performing it well.

Fluid intelligence Ability to apply knowledge and skills in novel situations.

Functional magnetic resonance imaging (fMRI) A functional neuroimaging technology for measuring brain activity by detecting changes in blood flow.

Focus Ability to remain alert and fix one's attention on a specific point, purpose, or task.

Food insecurity Limited availability or uncertainty about the availability of nutritional foods.

Formative assessment A type of assessment that focuses on measuring student progress toward mastery of a concept or skill in order to identify ways in which teaching needs to be modified to promote learning.

Frontal lobe One of four main areas of each hemisphere of the cerebrum; this lobe controls voluntary movement, verbal expression, problem solving, willpower, and planning.

General factor theory of intelligence (or *g*-factor) Theory of intelligence, originally developed by Charles Spearman, that defines intelligence as a single ability that is applicable across a broad range of tasks and activities.

Genetic and environmental influences on development Various influences that affect the way in which an individual's brain develops. Scientists now agree that both genes and environmental influences—nature and nurture—play a role in development and interact with each other in complex ways.

Glial cells Special "glue" cells in the brain that surround each neuron, providing support, protection, and nourishment.

Goal setting The act of setting goals in order to increase motivation.

Growth mindset Similar to the incremental view of intelligence, the growth mindset identified by Carol Dweck describes a viewpoint that assumes individuals can make themselves more intelligent.

Habituation Characterized by monotony—giving the brain too much of one signal, such as one sound (monotone) or one voice (monologue)—thus causing a child to tune out and be more prone to distractions; also known as *neuronal habituation*.

Happiness set point Inherent tendency toward positivity or negativity; researchers have determined that one's set point typically influences about 50 percent of one's outlook.

Higher-order thinking Thinking skills that help one control other cognitive processes and that are critical to developing knowledge; related to metacognition.

Hippocampus Part of the brain involved in short-term to long-term memory processing.

Human capital Attributes that individual teachers bring to their profession (e.g., education, teaching experience, subject matter knowledge).

Implementation Science A field of research and theory that focuses on improving the implementation of programmes in a variety of setting.

Incremental learning Ensuring that all students begin with the basic skills and knowledge they need to continue to make steady academic progress through progressively more complex lessons.

Informal learning "Accidental learning" or "learning from experience" outside formal educational programmes and without stated learning objectives.

Information-gathering skills Using multiple sources of information from trustworthy sources to effectively solve problems.

Initiative Cognitive ability to display readiness and skill in taking action.

Input-Processing-Output Model of Learning Approach to teaching and learning, based on the information processing conceptualization of learning, that divides the process of learning into three phases: input, in which students develop goals and a plan for learning; processing, in which they gather needed information and practice new skills; and output, in which they demonstrate and apply the knowledge and skills they have learned.

Intelligence quotient (IQ) A score on a standardized test that is meant to assess one's intelligence level.

Intelligence Capacity to understand, adapt to, and learn from our environment and experiences.

Kirkpatrick Model Four-level standard designed to evaluate the effectiveness of training for participants and the organization.

Learning sciences Diverse disciplines from which theories and research can be applied to improve our understanding of how people learn, including neuroscience and cognitive science; educational, developmental, cognitive, social, and positive psychology; anthropology and sociology; pedagogy; applied linguistics; and computer science. Applications from these disciplines can be applied to the cognitive, psychological, affective, and social aspects of human learning, to instructional methods, to the design of curricula and learning environments, and to the development of educational policy and systems.

Lifelong learning Brain's ability to change and develop as a result of new experiences throughout the life span, not just during childhood.

Limbic system Structures at the base of the cerebrum that control emotions; the five major structures are the thalamus, hypothalamus, basal ganglia, amygdala, and hippocampus.

Locomotor skills Ability to move from place to place.

Low birth weight Defined as an infant who weighs less than 2,500 grams (approximately 5½ pounds) at birth.

Making inferences Cognitive ability to go beyond the information given to solve problems and identify logical conclusions.

Malleable intelligence Principle that intelligence is not a fixed trait but rather can be enhanced through experiences and environmental influences; see also *brain plasticity*.

Manifest skills The skills and abilities that students demonstrate at a particular moment in time—for example, on starting a new school year.

Mastery goals Goals that are internally driven, such as building skills or increasing mastery of a task.

Memory Process by which the brain stores and retrieves information; *explicit* memories are those tied to specific experiences, whereas *implicit* memories are skills and knowledge the brain retains without recalling the experience of learning them.

Mentalizing network A term used by M.D. Lieberman to describe a set of brain regions that support thinking about other people's goals, thoughts, and feelings; when this network is active, it appears to be processing social information.

Metacognition Act of thinking about one's thinking with the aim of identifying strategies useful for solving a problem at hand and improving one's use of those strategies.

Mind, brain, and education (MBE) Field concerned with facilitating a cross-cultural collaboration in biology, education, and the cognitive and developmental sciences. Objectives include (1) improving the state of knowledge in and dialogue between education, biology, and the developmental and cognitive sciences and to create and develop resources for scientists, practitioners, public policy makers, and the public and creating and identifying useful information, research directions, and promising educational practices.

Mirror neurons Special cells in the brain that are activated when seeing someone perform an action and cause the individual's brain to respond as if his or her body were doing the same action.

Mnemonic Memory device that reduces a large body of information to a shorter, more memorable form by using a letter to represent each shortened piece of information.

Modeling Demonstrating appropriate behavior and social skills with the objective of having others learn and exhibit similar behavior and skills themselves.

Motor cortex Part of the brain that receives and uses information to carry out body movements.

Movement in the classroom Incorporating movement in the classroom to help students stay focused and energized.

Myelin White, fatty substance that forms in segments to surround and insulate a neuron's axon; myelin is responsible for the color of the white matter in the brain and spinal cord.

Myelination Process of surrounding and insulating neurons to facilitate faster transmission of nerve impulses.

Neocortex The outer folded layer of the brain that covers the cerebrum and cerebellum; plays an important role in memory and higher-order information processing; also known as *cerebral cortex*.

Neurocognitive capacity The brain's capacity to learn and change given the right conditions for learning to occur.

Neurocognitive synergy Conscious recognition of one's ability to influence dynamic interactions of brain functions, including neurogenesis, synaptogenesis, myelination, and angiogenesis, with the aim of becoming functionally smarter, more optimistic, more productive, and emotionally and physically healthier.

Neurogenesis Creation of new neurons in the brain.

Neuron Basic cell of the nervous system, consisting of a long fiber called an axon, which transmits impulses, and many shorter fibers, called dendrites, which receive them; the three

main types of neurons are sensory, association, and motor; see also *axon, dendrite,* and *synapse*.

Neuronal habituation See *habituation*.

Neuroplasticity See *brain plasticity*.

Nonimmediate talk Conversations with children that extend reading experiences.

Occipital lobe One of four areas of the brain, primarily involved in the ability to see and perceive visual information.

Omega-3 fatty acids Polyunsaturated fats with anti-inflammatory properties that help protect against cardiovascular disease and stroke and support brain health.

Parietal lobe One of four areas in the brain, which deals with the reception of sensory input and plays a role in reading, writing, language, and calculation.

Peer Coaching A collaborative and confidential process where small groups of educators reflect on current practices, refine teaching strategies, conduct action research, and work together to solve problems.

Performance goals Goals that are externally driven, such as meeting others' expectations or achieving high grades.

Phoneme Smallest unit of speech, as in the k-sound in *cat*, that distinguishes one word or utterance from another.

Phonemic awareness Ability to hear and identify the smallest structural units of sound in a language; see also *phoneme*.

Planning and organizing Cognitive ability to make plans and organize information to create a well-expressed, thoughtful response.

Plasticity See *brain plasticity*.

Positron emission tomography (**PET**) A nuclear medicine functional imaging scanning procedure used for the observation of metabolic processes.

Postural skills Ability to position the body.

Potential Neurocognitive capacity for acquiring the knowledge, skills, and attitudes to achieve to a higher level of performance in any domain.

POWER framework A structure for evaluating and improving education systems: Potential, Opportunity, Work, Encouragement, and Results.

Practical metacognition Process of establishing clear intent about what one wants to achieve; planning and executing action steps; and assessing, monitoring, and adjusting thoughts and actions to continue to make positive progress.

Practical optimism Strategy for learning that fosters positive expectations as a means of optimizing positive outcomes.

Practice-based research An original investigation undertaken to gain new knowledge partly by means of practice and the outcomes of that practice.

Prefrontal cortex Part of the brain associated with the ability to regulate and express emotion and to think and plan.

Preterm birth Birth that occurs at less than 37 weeks gestation.

Problem definition Cognitive ability to correctly define a problem so that one can generate an appropriate solution.

Professional advocacy Teachers' efforts to promote attitudes, actions, and endeavors that support student learning, school improvement, and the furthering of their profession.

Professional learning community Collaborative learning by teachers, characterized in formal programmes by recurring cycles of collective inquiry and action research with the aim of improving student achievement.

Propensity score matching Statistical technique in which a treatment case is matched with one or more control cases based on each case's propensity score with the aim of strengthening causal arguments in quasi-experimental and observational studies by (1) reducing the impact of selection bias and (2) minimizing baseline differences between the two groups.

Proper nutrition Emphasis on healthy eating (a diet that relies more on fruits, vegetables, lean protein, and whole grains with fewer fatty and high-carbohydrate foods) to help students stay engaged and focused on learning.

Prosody Rhythm and speech intonations of spoken language.

Pruning Process through which neural connections created as a result of experiences that are not repeated are eliminated.

Purposeful collaboration A process for intentionally harnessing the collective expertise of groups of individuals in the pursuit of common goals.

Pygmalion effect Influence that high expectations can have on student achievement.

Resilience The ability to recover from losses and setbacks and to persist in the face of challenges.

Scaffolding Learning process that builds on skills children already possess and provides support to help them develop additional skills and achieve subsequent learning goals via guidance from an adult or more knowledgeable peer.

Science of learning Interdisciplinary field that emerged in the 1970s with the aim of bridging research from psychology, computer science, philosophy, sociology, and other disciplines to practice in real-world educational settings.

Selective attention Cognitive ability to identify and focus on what is important in any given situation.

Self-control Ability to control detrimental behavior, emotions, and impulses and/or to stay focused on a required task without giving in to distractions; considered part of *executive function*; also known as *self-regulation*.

Self-directed learners Learners who take initiative and are empowered to actively identify and use resources that can assist them in learning.

Self-regulation See *self-control*.

Sensitive period Time when a particular part of the brain is most apt to change and most vulnerable to environmental influences. Also known as *critical period*.

Social capital A form of cultural and economic capital grounded in productive social networks.

Social cognition A sub-topic of social psychology focused on how human beings process and apply information about social contexts and relationships with others.

Social encoding advantage The potential for superior performance that may be experienced when learning occurs within a social cognitive context and the encoding, storage, retrieval, and processing system is enhanced.

Social play Most sophisticated form of play; often involves pretending and role playing.

Spectrum of Teacher Leadership The myriad of different ways that teachers can contribute to schools and districts beyond their own classrooms.

Strength training Form of exercise designed to build muscle, which has been demonstrated to improve both physical and neurocognitive functioning.

Stress management Strategies to relieve unhealthy levels of stress that can impair cognitive processing; classroom environments that are safe, positive, and accepting can help reduce stress and allow students to focus on learning.

Subjective well-being Assessment of one's feelings and tendency toward optimism vs. pessimism or positive vs. negative outlook.

Summarizing Cognitive ability to identify what is most relevant or important and communicate it in a concise manner, verbally or in writing.

Synapse Microscopic gap between the axon of one neuron and the dendrite of the next neuron where the neurotransmitters are released to stimulate the next neuron; the junction communication point where neurons interact; see also *neuron*, *axon,* and *dendrite*.

Synaptogenesis Process through which the brain creates new synapses.

Teacher leadership Process through which teachers, collectively or individually, influence their colleagues, school communities, and administrators in ways that support improved teaching practice and student learning.

Temporal lobe One of four areas located on the side of the cerebrum; involved in hearing, memory, and understanding language and time; because of its connection to the limbic system, the temporal lobe also plays a critical role in emotions.

Theory of Mind Ability to predict or surmise how others might think and react in a certain situation based on one's own personal experience.

Toxic stress Harmful form of stress characterized by strong, frequent, or prolonged activation of the body's stress management system due to chronic, uncontrollable stress events in the child's life that are often endured without the support of a caring adult.

Transfer Influence of past learning on new learning and the degree to which new learning will be useful to the learner's future.

Types of reflection Forms of metacognition used by teachers in their professional practice; as described by Donald Schön, one of the founders of organizational learning, *reflection in action* refers to the ability to reflect on and address a problem while one is in the midst of the activity, and *reflection on action* refers to thinking about a problem or challenge after the activity has concluded.

Understanding others' points of view Cognitive ability to understand and respect other people's viewpoints through the display of empathy and development of rapport.

Vestibular system Sensory system that controls the sense of movement and balance.

Wernicke's area Area in the brain's frontal lobe that has been identified as being integral to language comprehension.

Working memory Temporary memory where information is processed consciously and used to solve immediate problems; part of *executive function*.

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