A Case Study: Tracking Meaningful Student Data

How does MindPrint Learning impact secondary math teachers' use of student data to prepare purposeful learning experiences that maximize student learning?

By

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May 2021

Abstract

The purpose of this qualitative case study was to investigate how cognitive skills impact academic success through the lens of secondary math teachers in a secondary high school in Washington D.C. public schools. More specifically, how the use of MindPrint Learning impacted teachers in preparing a purposeful learning experience and responding to evidence of student learning by secondary mathematics teachers. Cattell Investment Theory of Capabilities, which centers on a student's learning capacities across formats and environments, suggests that cognitive skills are the key driver of academic achievement (e.g., Cattell, 1971 & 1987) and provides the foundational research on which this study is based.

The study focused on 12 high school educators consisting of 11 secondary math teachers and one instructional coach in Anacostia High School who use data trackers to improve teaching and learning and personalize instruction. Participants committed to the following over an eight-week pilot period (February 2021 - April 2021):

- Assessment of students with MindPrint (1 hour) (n=27);
- Bi - Weekly Teacher PLCs facilitated by MindPrint;
- MindPrint review of individual student strengths and needs;
- MindPrint recommendation for whole class and individual strategies

The eight-week period was sufficient to change teacher perspective on student learning needs and capabilities. Teachers were receptive to the new instructional approaches that could be expected to meaningfully improve outcomes. Further study is needed to track changes in teacher behaviors and corresponding improvement in student outcomes.

Reseach

Research Question: How does MindPrint Learning impact secondary math teachers' use of student data to prepare purposeful learning experiences that maximize student learning?

Rationale: This qualitative case study investigated how cognitive skills impact academic success through the lens of secondary math teachers in District of Columbia Public Schools (DCPS). The case study focused on eleven secondary math and one instructional coach who use data trackers to improve teaching and learning.

Study Background: This 8-week study was led by Donald Thompson, Jr., high school math teacher, as part of the American Federation of Teachers (AFT) and the local Washington DC Teachers Union (WTU) Teacher Leader Program (TLP). The TLP provides selected teachers the resources to study a cutting-edge topic in education and make a change recommendation to the district. This qualitative study provides the foundation to determine if this program should be implemented in a more systematic way throughout the district.

Background on MindPrint Learning and Cognitive Skills: The MindPrint solution includes an assessment of nine distinct sub-tests developed at the University of Pennsylvania's Brain Behavior Lab in collaboration with the National Institute of Mental Health. This standard-referenced self-administered online assessment is suitable for

students aged 8-21. MindPrint enables educators to understand how students learn best to tailor instruction to student's natural learning strengths and needs. The assessment provides recommendations and instructional tools for whole class instruction, small group differentiation, personalized learning, standardized test preparation, and the development of social-emotional skills. Instructional support is core to teacher professional development in the science of learning best practices. It is critical to make data-informed decisions to improve instruction that will lead to growth in student achievement.

Current academic data is valuable, and it is essential to make data-informed decisions to improve teaching and student outcomes. However, in the absence of cognitive data, teachers rely on guesswork and intuition when students fail to perform or behave in optimum ways to prepare for instruction in the virtual and in-person setting. Achievement data provides valuable insight into students' mastery but does not tell why a student struggles and what specific types of support they need. By effectively understanding and providing students instruction based on cognitive skills, educators have the insights to help students improve their academic and social-emotional skills, resulting in enhanced outcomes and a virtuous learning cycle.

Definition of Cognitive Skills: The MindPrint battery assesses 10 skills across four core domains. The contribution of these skills to learning varies by age, academic

subject and individual. The areas of greatest typical impact are highlighted after each skill.

Complex Reasoning is the ability to analyze information and solve problems. You might see it referred to as “higher order thinking.” Students can be strong in one area of reasoning but not in another, which can be a source of confusion and frustration for teachers, parents, and students alike. Verbal Reasoning and Abstract Reasoning combine to form Critical Thinking.

- **Verbal Reasoning** is the ability to understand language-based information. *Biggest impact: all subjects particularly when reading, writing, or speaking. Greatest predictor of overall academic achievement.*
- **Abstract Reasoning** is the ability to understand non-language-based information, including numbers, shapes, and patterns. *Biggest impact: math and science, particularly in higher grades. Core to STEM careers such as medicine, engineering, and computer science.*
- **Spatial Perception** is the ability to visualize how objects relate in space. *Biggest impact: math and science, especially geometry and physics; hands-on activities; fine and performing arts. Core to creative careers including engineering, design, and the arts.*

Executive Functions are the traits that involve organizing thinking for efficient task completion. Even students with the strongest reasoning skills might have difficulty efficiently completing assignments if they have weaker Executive Functions.

- **Attention** is the ability to sustain focus and complete tasks to the best of one's capability, even tasks that might not be engaging. ***Biggest impact: All subjects, particularly those for which the student does not have intrinsic motivation, time management, self-regulation***
- **Working Memory** is the ability to mentally juggle multiple bits of information in short-term memory. ***Biggest impact: Multi-step problem solving in math and science, reading fluency, following directions, organization, self-management***
- **Flexible Thinking** is openness to taking feedback and adapting. ***Biggest impact: Complex problem solving in middle and high school; Adjusting to unexpected situations or novel problems, self-awareness, collaboration***

Memory refers how a student takes in and organizes information to recall it under different circumstances. It is common for students to have one memory skill that is significantly stronger than another. It is often beneficial to recognize the stronger skill and use that to improve learning and homework efficiency.

- **Verbal Memory** is the ability to remember and recall language-based information. ***Biggest impact: All subjects, particularly in earlier grades when foundational skills are most important.***
- **Visual Memory** is the ability to remember and recall objects, pictures, patterns, formulas, and other visual information. ***Biggest impact: Math facts, math, and science more generally, visual arts.***

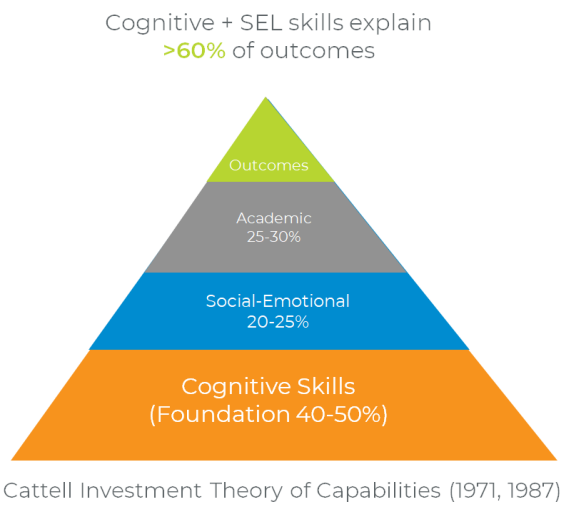
Speed describes how quickly and accurately a student works. Students who work at a slower pace might feel like they cannot do the work, when they just need more time. In contrast, students who work efficiently are able to complete work within the expected time and have the luxury of using extra time to check work, take on more challenges, or relax before the next task.

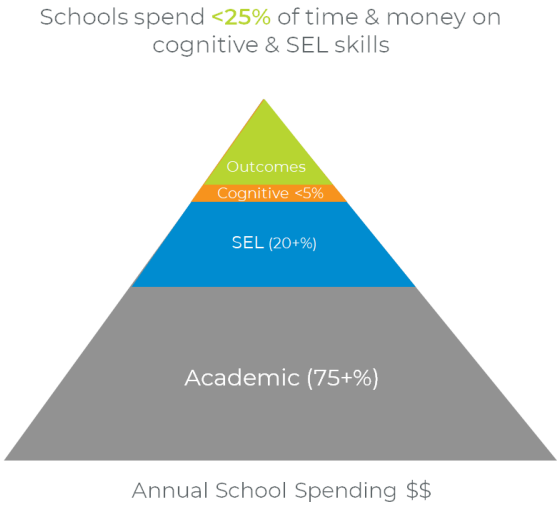
- **Visual Motor Speed** is how efficiently your eyes and hands work together. ***Biggest impact: Handwriting, keyboarding, note taking, hands-on activities.***
- **Processing Speed** is how efficiently you process and respond to new information. Processing has several sub-categories, including auditory, verbal, and visual. ***Biggest impact: Class participation, standardized tests, reading efficiency and homework efficiency.***

Literature Review: In the absence of cognitive data, teachers are left to rely on guesswork and intuition when students do not perform or behave in optimal ways. Even at high-performing, wealthy high schools, students who have fallen far behind academically in 4th or 8th grade have less than a 1 in 3 chance of being ready for college or a career by the end of high school (Dougherty and Fleming, 2012). Cognitive skills are a far more reliable predictor of academic success and potential than social-emotional skills or student grades **(**Cattell, 1971 & 1987; Woodcock & McArdle, 1998; Ferrer & McArdle, 2004). They explain a student's learning capacities across formats and environments and determine the most effective and efficient instructional delivery methods for a particular learner. Cognitive ability is central to predicting academic

outcomes and job performance (Leeson & Heaven, 2008; Gómez-Veiga, Vila Chaves, Duque, and García Madruga, 2018).

The following figures show the inconsistency between what research demonstrates is proven to lead to positive outcomes in education compared to how schools allocate their spending budgets. This misalignment is likely a contributing factor to flat educational outcomes and lower than desired proficiency levels in math and science (MindPrint Learning, 2020).





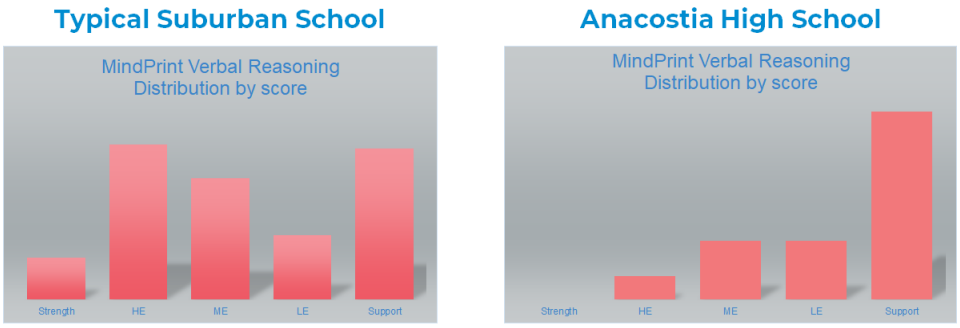
Research on Verbal vs. Non-Verbal Reasoning. Verbal Reasoning, or the ability to understand what you read and hear, is a skill mostly highly correlated with academic success through high school. Schools are incredibly language-based environments, requiring students to depend heavily on reading, writing, and listening in all subjects. In fact, Verbal Reasoning is the skill most predictive of scores on the SAT and ACT, even on the math and science sections.

In contrast, college and career success depend on a much broader set of skills. Notably, STEM careers are heavily dependent on Spatial and Abstract Reasoning. By measuring and addressing a broad set of cognitive skills, MindPrint provides insight into why students might struggle in school because of weaker verbal skills, and yet show strong potential in other areas that might be missed by traditional classroom and standardized tests. MindPrint provides opportunities to nurture these non-verbal strengths. MindPrint also provides guidance on how to modify instruction for students with weaker verbal skills and/or those who have strong verbal skills but have other cognitive skills that might be interfering with their learning in a traditional classroom, namely Executive Functions, Memory, and Efficiency.

Instruments and Data Sources: Data was collected from a teacher pre/post questionnaire, six weekly teacher reflections aligned with the MindPrint Learning trainer's professional development, and objective student profile data using the MindPrint Assessment (one hour).

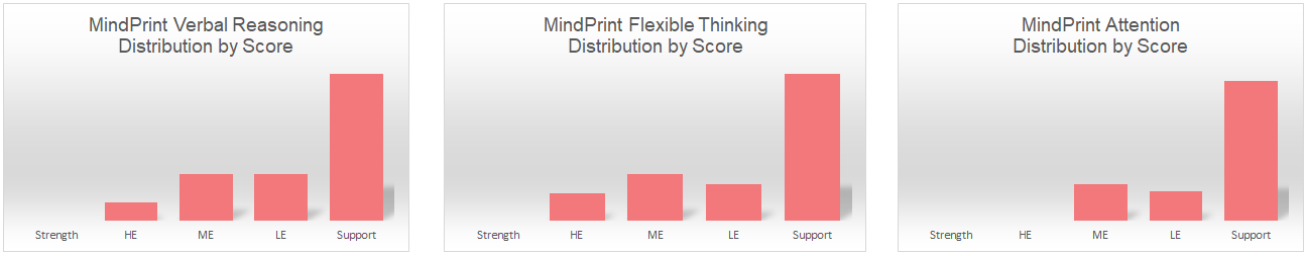
Weekly reflections were collected from February to April 2021, focusing on teacher understanding of the science of learning and cognitive skills during bi-weekly PLCs facilitated by MindPrint. During the PLCs, MindPrint reviewed individual student strengths and needs and recommended whole class and individual strategies associated with the MindPrint student assessment. Data analysis was based on a combination of quantitative (student profile analysis) and qualitative (teacher reflections) measures.

Student Profile Analysis: Originally the study was designed to provide individual recommendations for each student to personalize instruction. However, a review of the data showed striking consistency in performance across students. This is not seen in higher income schools, where students show variability by cognitive skill. An example of Verbal Reasoning distribution for a typical suburban school and Anacostia is shown below for comparison.



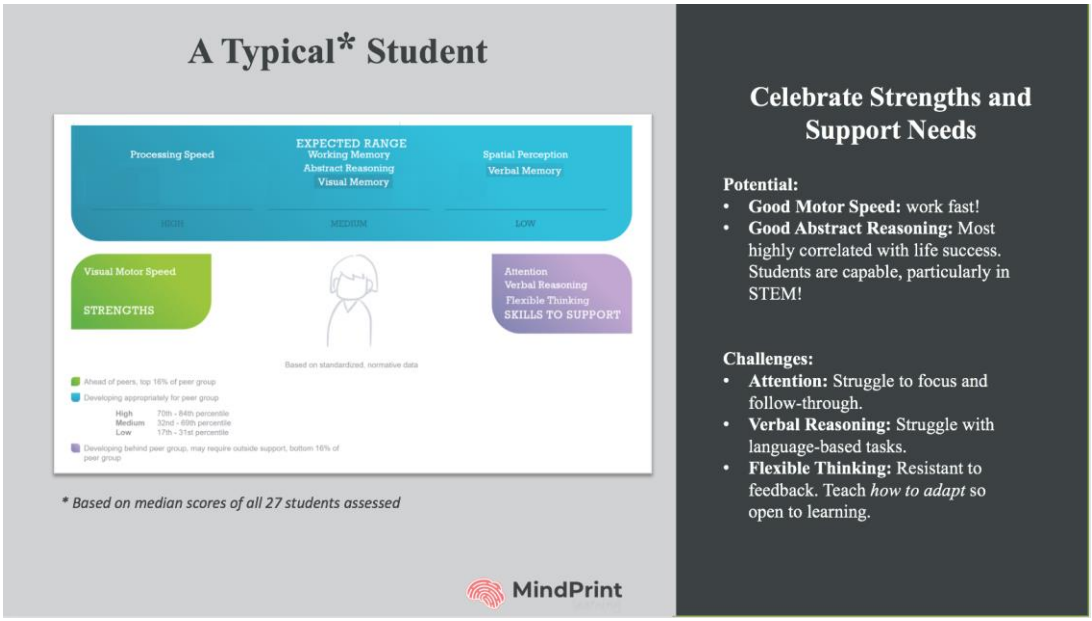
Percentile by category: Strength(t85-100%), HE (70-84%), ME (32-69%), LE (17-31%), Support (1-16%)

The three skills that showed the highest consistency among Anacostia students were Verbal Reasoning, Flexible Thinking, and Attention, with students concentrated at the struggling end of the distribution. It is notable that the needs objectively identified by the MindPrint assessment were consistent with research on students living in high poverty communities.



Percentile by category: Strength (85-100%), HE (70-84%), ME (32-69%), LE(17-31%), Support (1-16%)

Since the skills where students disproportionately struggled are also highly correlated with academic success in K12, the decision was made to focus on helping teachers understand the primary needs of most of their students before focusing on individual learner variability. Teachers were presented with the profile of a “typical student” so they could reflect on how best to support the strengths and needs of most students in their classrooms. Given the small sample size (n=27), median scores were used instead of average scores to avoid skewing the results from data in the tails of the distribution.



The median student demonstrated good potential in **Motor Speed, Abstract Reasoning, and Visual Memory** (36th percentile or higher). This is notably much higher than their corresponding verbal scores (below 16th percentile) as well as their math achievement scores (below 10th percentile). According to Berkowitz and Stern (2018) visual-spatial reasoning has the highest positive correlation of success for students in STEM fields. This differential between abstract reasoning capabilities on MindPrint and

math achievement scores on traditional standardized tests suggests students' might be significantly underperforming their potential, particularly in STEM.

In contrast, most students had challenges with **Verbal Reasoning, Attention, and Flexible Thinking** (below 16th percentile). These results are consistent with research that students living in poverty are shown to have weaker Executive Functions (i.e., Attention and Flexible Thinking) as a result of exposure to chronic stress (Diamond, 2014). Students also tend to have lower Verbal Reasoning (Kaya, Stough, and Juntune, 2021) than their higher income peers. Lower Verbal Reasoning is consistent with the students' lower reading achievement scores.

In short, the MindPrint data, in combination with the school's achievement data, provides insight into why Anacostia students are underperforming their higher income peers and offers potential opportunities to meet students where they have the greatest need. It also makes clear that students living in poverty likely require different structural supports than their higher income peers. Namely, schools must focus on supporting students who struggle with Attention and Flexible Thinking deficits resulting from exposure to chronic stress. If students cannot focus, they will not be learning, regardless of student capability and teacher/curriculum quality. Strategies like daily mindfulness and meditation can help. Designing classrooms with fewer distractions and providing frequent, scheduled breaks are also critical to supporting students with Executive Functions challenges.

Verbal Reasoning is indisputably a separate but equal challenge. Verbal Reasoning has the highest correlation to success in K12 classrooms as it is highly

linked to reading literacy. Not surprisingly, students with weaker Verbal Reasoning skills struggle on achievement assessments in reading and math. While verbal skills must be addressed directly, teaching students to compensate with their stronger visual skills can improve their understanding and bolster their confidence. Schools can supplement language-based tasks by providing students opportunities to learn through multi-modal reinforcement including visualization, visual aides, and hands-on learning. While visual reasoning cannot substitute for language skill development, it can help students compensate in very meaningful and effective ways, particularly in STEM classes.

While students generally showed consistency across cognitive skills, there were students who notably deviated from the median in very positive ways. Seven (7%) percent of the students qualified as gift (top 5% of the nation in Abstract Reasoning) even with their measured Attention challenges. This **percent of gifted learners is consistent with national norms and** suggests that Anacostia had unrecognized students that are capable of top performance by any standard. An additional seven (7%) were gifted in Spatial Perception. These statistics suggest that traditional achievement tests are failing to identify highly capable learners in high poverty districts. We hypothesize this is because weaker Verbal Reasoning and Executive Functions skills mask these students' visual strengths on traditional assessments and in the classroom.

Results & Implications: As the results of this study are consistent with other schools with a high percentage of Free and Reduced Lunch (FRL) students (MindPrint, 2020), it is important for educators in high poverty schools to understand that weaker Executive Functions and Verbal Reasoning are likely the norm for their students and manage their

classrooms accordingly. In PLCs, teachers discussed how to systemically address executive function challenges. Discussions included developing a common understanding of what it means to have weaker Executive Functions and why it is not something that is under students' control. Teachers discussed using strategies like mindfulness and regular breaks to help students sustain focus. Teachers were reminded that the content and standards do not change, but the presentation does where possible to account for students' stronger visual skills and weaker verbal skills. The limited time of the study did not allow for monitoring of teacher use of the strategies and whether they were successful. However, teacher reflections suggested teachers were ready to adopt this new data-driven approach to informing their instructional practices.

Selected Teacher Reflections: The vital role of teacher acceptance in adoption of new teaching and learning tools is widely understood (Teeroovengadum, Heeraman and Jugurnath, 2017). The data of the teacher reflections established four themes of why teachers are likely to value and request this additional data on their students: a new lens on the learner, beneficially, improving practice, and the process is not incremental work. The following are teacher quotes:

A new lens on learners

"The student academic data reports in our PLC trackers do not reflect the students' capabilities; it only reflects proficiency data. The data tracker does not identify the student's cognitive strengths or weaknesses to enrich learning and build in intervention

strategies to meet the needs of students. It is a preference to complete a MindPrint assessment at the beginning of the school year to plan for student instruction effectively."

Beneficial for everyone

"There is a need for teachers, students, and administrators to complete a MindPrint assessment as a reflection tool. All involved in the educational process need to be able to make decisions that support the typical student, and the talented and gifted."

Improving practice

"If we know how our students think and learn, we can tailor our instruction to them to create a more efficient learning environment."

Not incremental work

"Thinking of methods, we know already can only enhance what we need to know when we have a clear roadmap."

Recommendations: The recommendation from this study is to implement MindPrint Learning at the beginning of the school year for students, especially students in 3rd grade and transitions from elementary school to middle school, and middle to high school. Without cognitive data, teachers have little insight into why students do not develop their academic and social skills for long-term academic achievement, despite a solid evidence-based curriculum and teacher support**.** Monthly MindPrint professional learning will be important to gain teacher understanding and acceptance during teacher PLCs.

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