



## Implementation of Online Cognitive Assessment and Training with Middle School Students Performing Below Academic Standards

### Background

During the 2021-22 school year, Urey Middle School in Walkerton, Indiana (John Glenn School Corporation) implemented a cognitive assessment and cognitive training program to help students improve their cognitive skills and academic performance. The school serves 7<sup>th</sup> and 8<sup>th</sup> grade students. The implementation was directed by Principal Gregg Goewert and students were coached through their cognitive training in BrainWare SAFARI by Pat Crone, a teacher and athletic director at the school.

Teachers and staff at the school selected 32 students, a combination of 7<sup>th</sup> and 8<sup>th</sup> graders, to participate in the initial pilot during the fall semester, based on their below-standard academic performance on formative and summative assessments. The school administered the Mindprint Cognitive Assessment at the beginning of the school year to all of the 7<sup>th</sup> grade students in the school and to the 8<sup>th</sup> grade students who had been selected to participate in the cognitive training program. 30 of the 32 students who participated in the cognitive training program took the Mindprint assessment again in December, 2021.

The positive results experienced during the fall semester led to a second cohort going through the program during the spring semester. Again, students were selected by teachers and staff because of academic performance concerns. Any selected 8<sup>th</sup> grade students who had not previously taken the Mindprint assessment did so at the beginning of the spring semester. The students in the spring cohort took the Mindprint assessment again in May, 2022. Mindprint data are available for 24 of the 26 students in the spring cohort.

### Cognitive Assessment

The Mindprint Cognitive Assessment produces scores for ten cognitive skills:

#### Executive Functions

- Attention (Sustained Attention)
- Working Memory
- Flexible Thinking

#### Memory

- Visual Memory
- Verbal Memory

#### Complex Reasoning

- Verbal Reasoning
- Spatial Perception
- Abstract (Nonverbal) Reasoning

#### Speed

- Visual Motor Speed
- Processing Speed

## **Cognitive Training**

Following the pre-test, students started their cognitive training, working in BrainWare SAFARI cognitive training software. BrainWare SAFARI develops 43 cognitive skills in a comprehensive and integrated manner, using techniques derived from multidisciplinary clinical collaboration; it is delivered in an engaging online video-game format.

The recommended protocol for using BrainWare SAFARI is 3 to 5 times per week, for 30 to 45 minutes per session, over at least 12 weeks. The Urey Middle School students assigned to participate in cognitive training did so in a daily class with Mr. Crone as their coach. Because BrainWare SAFARI is presented in a video-game format, most students engage readily in the program. The role of the coach is to encourage and support students and to provide direction as needed to make sure they work across multiple exercises (games) in the program, rather than focusing only on the ones that they find easier or particularly enjoy.

## **Cognitive Gains Following Student Use of BrainWare SAFARI – Fall Cohort**

On average, the 30 students who worked in BrainWare SAFARI and for whom Mindprint pre- and post-test data are available completed 44 sessions, well within the target number of sessions, with a minimum of 28 sessions and a maximum of 53 sessions. The students completed an average of 80 levels (minimum of 36 levels, maximum of 148) of the 168 total levels in BrainWare SAFARI. The number of sessions completed is more important than the number of levels completed in terms of having an impact of performance on cognitive tests and academic growth.

Figure 1 shows the average scores on the pre-test and the post-test, represented as percentile rankings<sup>1</sup>, for the 30 students in the fall cohort for each of the ten cognitive skills.<sup>2</sup> The blue lines on the chart mark the 17<sup>th</sup> percentile and the 84<sup>th</sup> percentile, which the Mindprint assessment terms “the expected range” (that is, scores that fall within one standard deviation of the mean based on national norms). The red lines mark the 32<sup>nd</sup> and 69<sup>th</sup> percentiles; scores in the range are considered to be in “the middle of the expected range,” or typical for their peer group.

---

<sup>1</sup> Student scores were reported and analyzed as Z-scores, indicating the distance or standard deviation from the mean for each student, based on their age (birth month and year) and gender peer group. They were then translated to percentile rankings which are often more familiar to educators.

<sup>2</sup> These results do not include Invalid/Inconclusive scores for these students. Invalid or inconclusive scores occur for a variety of reasons, including technical difficulties, lack of understanding of what was being asked, or rushing through a test, as well as the possibility that the students simply did not have the sufficient skill in that area to perform the test. In some cases, students were not able to complete the test due to absence which would also result in an invalid or inconclusive score. Thus, invalid scores were not included in the averages.

## Fall Cohort 7<sup>th</sup> & 8<sup>th</sup> Grade - Average Percentile Rankings Before and After Using BrainWare SAFARI

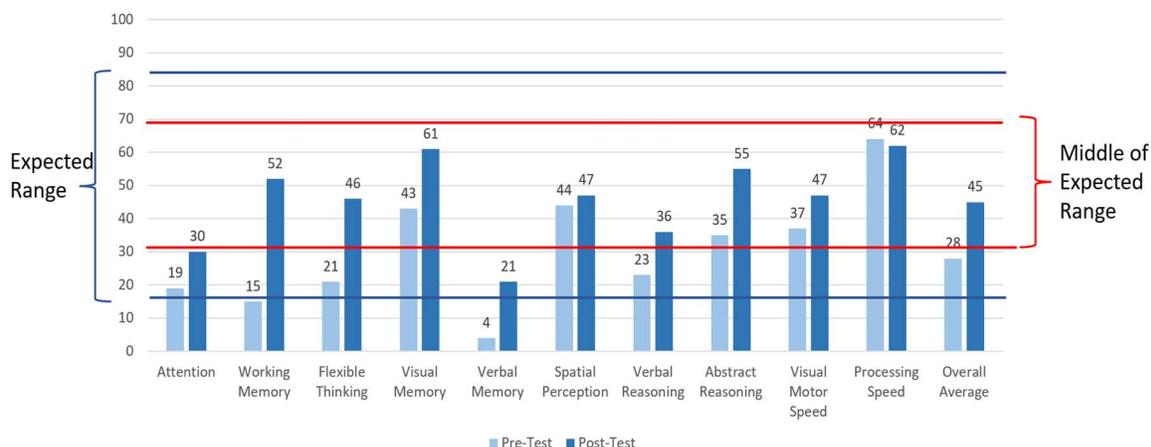


Figure 1. Average Percentile Rankings by Cognitive Skill for 30 Students in Fall Cohort, Pre- and Post-Test

Average percentile rankings for these students on the pre-test were at or below the 32<sup>nd</sup> percentile for five of the ten cognitive skills measured – attention, working memory, flexible thinking, verbal memory and verbal reasoning. Students scoring in this range will require support to overcome the potential academic and behavioral impact of the weaker skills.

- Attention refers to sustained attention. Students with weaker attention skills often experience gaps in the information they take in and may require frequent refocusing or redirection in the classroom.
- Working memory refers to the ability to hold information in mind while thinking about it long enough to perform some task with it. Students with limited working memory capacity often have difficulty with reading comprehension, tracking their progress through multi-step math problems and following through on a set of instructions.
- Students with weak flexible thinking skills have difficulty adapting to changes in the environment and adjusting their approach when an initial approach doesn't work; they often are less effective at looking at situations from multiple perspectives.
- Students with weaknesses in verbal memory often struggle when asked to remember words, stories, or other text-based information, such as information discussed in class, written on a board or read in a text or other written source.
- Students with weaknesses in verbal reasoning typically struggle with drawing inferences, understanding figurative language and generally understanding language-based information.

The data support the initial concern that there were significant underlying cognitive weaknesses contributing to the below-standard academic performance of these students.

On post-test, average student scores improved for nine of the ten test areas. Average scores for processing speed remained consistent with the pre-test average. Average percentile rankings increased to within the expected range across all cognitive skills and all but one (verbal

memory) increased to within the middle of the expected range. The students showed significant improvement on all of the Executive Functions tests (Attention, Working Memory and Flexible Thinking) and the memory tests. Overall, the students demonstrated an improvement of 18 percentile points across all of the tests (an average improvement of 0.55 standard deviation).

70% of the students experienced a meaningful gain across all cognitive skills measured during the fall semester, as shown in Figure 2.

Average Cognitive Gains	Number of Students	Percentage of Students
1.0 SD or greater	4	13%
0.5 SD to < 1.0 SD	10	33%
0.25 to < 0.5 SD	7	23%
< 0.25 SD	9	30%

Figure 2. Percentage of students achieving cognitive gains.

While most students experienced gains of at least 0.25 SD across all of the cognitive skills tests, all students with valid test scores for at least three of the ten tests experienced gains in one or more test areas, as shown in Figure 3.

Number of Skills (Test Areas) Improved	Number of Student Improving on the Number of Skills
1	1
2	1
3	2
4	7
5	4
6	7
7	3
8	1

Figure 3. Student gains in multiple test areas.

### **Cognitive Gains Following Student Use of BrainWare SAFARI – Spring Cohort**

On average, the 24 students who worked in BrainWare SAFARI during the spring semester completed 56 sessions, again well within the target number of sessions, with a minimum of 35 sessions and a maximum of 68 sessions. The students completed an average of 106 levels (minimum of 32 levels, maximum of 168) of the 168 total levels in BrainWare SAFARI.

Figure 3 shows the average scores on the pre-test and the post-test, represented as percentile rankings, for the 24 students in the spring cohort for each of the ten cognitive skills. The blue lines on the chart mark the 17<sup>th</sup> percentile and the 84<sup>th</sup> percentile, which the Mindprint assessment terms “the expected range.” That is, scores in that range fall within one standard deviation of the mean based on national norms. The red lines mark the 32<sup>nd</sup> and 69<sup>th</sup> percentiles; scores in the range are considered to be in “the middle of the expected range,” or typical for their peer group.

### Spring Cohort 7<sup>th</sup> & 8<sup>th</sup> Grade - Average Percentile Rankings Before and After Using BrainWare SAFARI

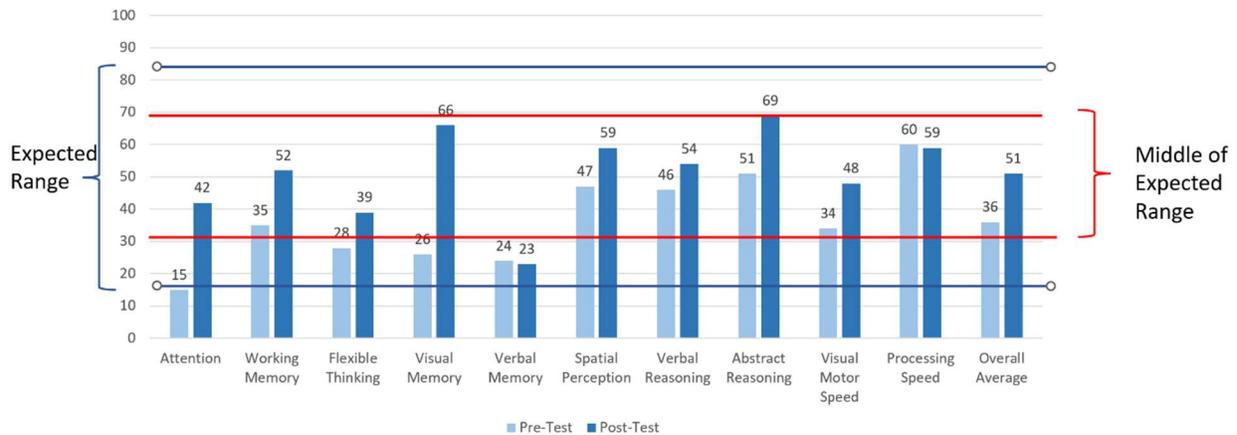


Figure 4. Average Percentile Rankings by Cognitive Skill for 30 Students in Spring Cohort, Pre- and Post-Test

Average percentile rankings for these students on the pre-test were at or below the 32<sup>nd</sup> percentile for four of the ten cognitive skills measured – attention, flexible thinking, visual memory and verbal memory. Students scoring in this range will require support to overcome the potential academic and behavioral impact of the weaker skills.

- Attention refers to sustained attention. Students with weaker attention skills often experience gaps in the information they take in and may require frequent refocusing or redirection in the classroom.
- Students with weak flexible thinking skills have difficulty adapting to changes in the environment and adjusting their approach when an initial approach doesn't work; they often are less effective at looking at situations from multiple perspectives.
- Students with weaknesses in verbal memory often struggle when asked to remember words, stories, or other text-based information, such as information discussed in class, written on a board or read in a text or other written source.
- Students with weaknesses in visual memory would be expected to make more errors recalling images, charts, graphs, diagrams and other non-language-based information.

On post-test, average student scores improved for eight of the ten test areas. Average scores for processing speed and verbal memory remained consistent with the pre-test averages. Average percentile rankings increased to within the expected range across all cognitive skills and all but one (verbal memory) increased to within the middle of the expected range. The students showed significant improvement on all of the Executive Functions tests (Attention, Working Memory and Flexible Thinking). Overall, the students demonstrated an improvement of 15 percentile points across all of the tests (an average improvement of 0.43 standard deviation).

58% of the students experienced a meaningful gain across all cognitive skills measured during the fall semester, as shown in Figure 5.

Average Cognitive Gains	Number of Students	Percentage of Students
1.0 SD or greater	3	13%
0.5 SD to < 1.0 SD	9	38%
0.25 to < 0.5 SD	2	8%
< 0.25 SD	10	42%

Figure 5. Percentage of students achieving cognitive gains.

While most students experienced gains of at least 0.25 SD across all of the cognitive skills tests, all students with valid test scores for at least three of the ten tests experienced gains in one or more test areas, as shown in Figure 6.

Number of Skills (Test Areas) Improved	Number of Student Improving on the Number of Skills <sup>3</sup>
1	1
2	5
3	1
4	3
5	3
6	4
7	6
8	1

Figure 6. Student gains in multiple test areas.

**Academic Impact**

Urey Middle School uses ClearSight Assessments to track student progress in English Language Arts and Mathematics. According to information on the company’s website, “ClearSight Assessments mirror the functionality and student experience used in more than 25 state tests.” Urey Middle School students took the ClearSight ELA and math assessments at the beginning of the school year and again in December. Average improvement for the students in the fall cohort of the cognitive training program, for whom both fall and winter scores are available were 18 scaled score points for ELA and 20 scaled score points for math. School leadership stated that grades earned by the students in their academic classes improved following their cognitive training, and that only one student in the cohort failed to complete a course in the fall semester, where historically multiple students with similar academic profiles fail at least one course.

In the spring of 2022, students took ILEARN (Indiana’s Learning Evaluation Assessment Readiness Network, the summative state assessment administered annually to students in grades 3 through 8). ILEARN data were analyzed separately for the 7<sup>th</sup> grade and 8<sup>th</sup> grade students who had taken BrainWare SAFARI, either in the fall or the spring semester, and compared to their performance the previous year when they were 6<sup>th</sup> or 7<sup>th</sup> graders respectively.

Knowing that these students were selected because of concerns about academic performance, it is helpful to look at their performance in the context of the performance of all the students in the district at their grade level. Data from the Indiana State Department of Education archives

---

<sup>3</sup> This count likely understates the number of skill areas in which students improved because it doesn’t count areas where students had an invalid score on the pre-test, because the skill was an area of exceptional weakness, but had a valid score on the post-test.

indicates that the 6<sup>th</sup> graders across the John Glenn district performed as follows on the ILEARN administered in the spring of 2021: 46% performed At or Above Proficiency in English Language Arts (ELA), 29% performed at the Approaching Proficiency level, and 25% scored at the Below Proficiency level. The following year, 53% of the students scored At or Above Proficiency as 7<sup>th</sup> graders in ELA, 29% scored at the Approaching Level and 18% at the Below Proficiency Level.

The 6<sup>th</sup> grade students who were selected to participate in the cognitive training program were chosen because they were lagging academically. As 6<sup>th</sup> graders, only 10% of the students in that group were performing At or Above Proficiency in ELA, 25% scored at the Approaching level, and 65% of the students performed Below Proficiency. As 7<sup>th</sup> graders, following their cognitive training program, the percentage of students scoring At or Above Proficiency more than doubled to 24%. The percentage that scored at the Approaching level almost doubled to 48%. And the percentage of students performing Below Proficiency was more than halved to 29%. These results are summarized in Figure 7.

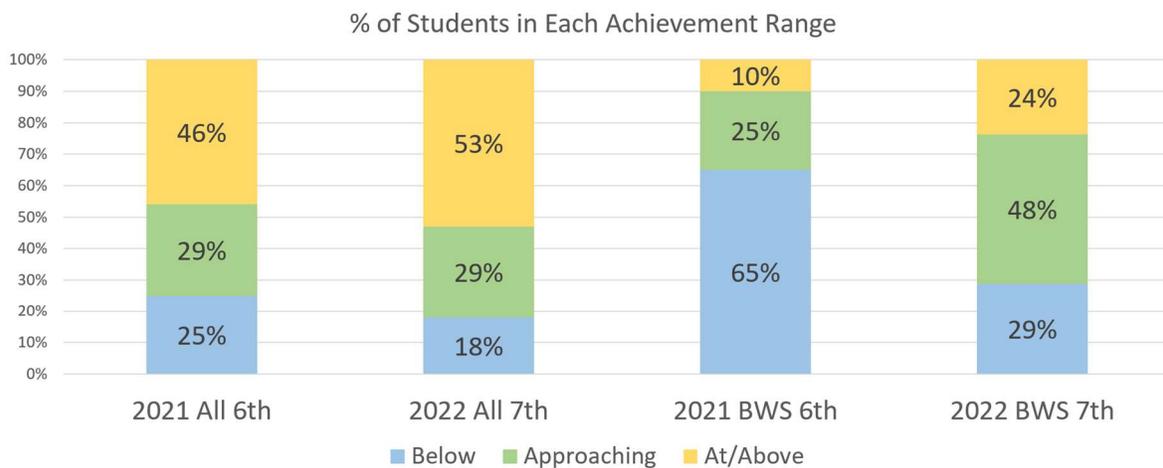


Figure 7. Percentage of students performing within achievement ranges on the annual ILEARN assessment for ELA, 7<sup>th</sup> Grade Students

Significant improvements in ILEARN scores were also experienced by the students in the BrainWare SAFARI group in math. When the 6<sup>th</sup> grade students in the district took ILEARN in the spring of 2021, 40% performed At or Above Proficiency in Math, 34% performed at the Approaching Proficiency level, and 25% scored at the Below Proficiency level. The following year, 43% of the students scored At or Above Proficiency as 7<sup>th</sup> graders in Math, 33% scored at the Approaching Level and 24% at the Below Proficiency Level.

As 6<sup>th</sup> graders, only 10% of the students in the BrainWare group were performing At or Above Proficiency in Math, 33% scored at the Approaching level, and 57% of the students performed Below Proficiency. As 7<sup>th</sup> graders, following their cognitive training program, the percentage of students scoring At or Above Proficiency remained the same. The percentage scoring at the Approaching level increased to 59%. And the percentage of students performing Below Proficiency dropped to 32%. These results are presented in Figure 8.

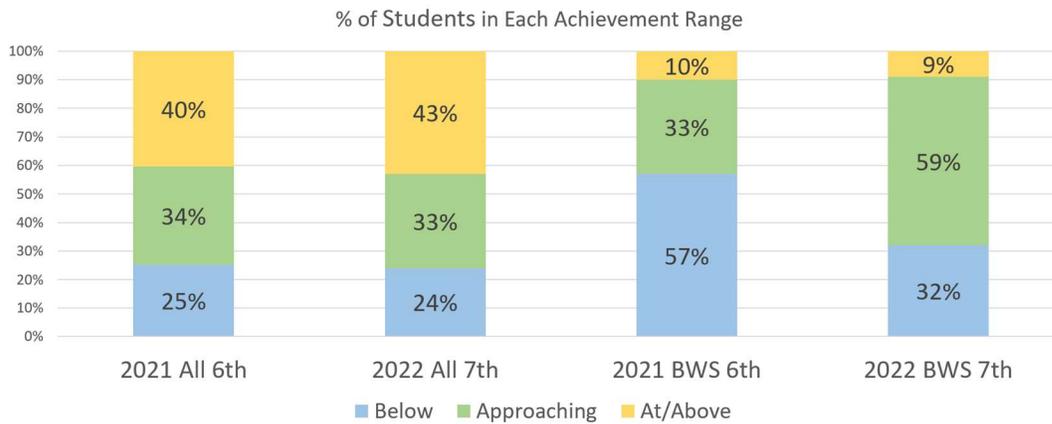


Figure 8. Percentage of students performing within achievement ranges on the annual ILEARN assessment for Math, 7<sup>th</sup> Grade Students

No substantive impact on the 8<sup>th</sup> graders' performance was observed on the percentages of students performing in different achievement ranges.

While moving between categories and helping a greater percentage of students perform proficiently at grade level standards is the ultimate goal, growth can also be measured within ranges and students may close the gap between their score and the “cut score” (the score required to be classified at the next level up). It should be noted that students at Urey Middle School took the ILEARN assessment in mid-April, at which point those in the spring cohort were only part-way through their cognitive training. It is the students in the fall cohort whose ILEARN scores would be expected to be positively impacted by their cognitive growth, both because they bring stronger cognitive skills to the testing process and because they have had the benefit of a few months of strong learning with their strengthened skills.

As the table in Figure 9 shows, 90% of the 7<sup>th</sup> grade students in the fall cohort improved their performance in ELA and/or Math on the annual ILEARN assessment. A performance level gain refers to a student moving from Below Proficiency to Approaching Proficiency or better or from Approaching Proficiency to At/Above Proficiency.

ILEARN Gain	# of Students	% of Students
Performance Level Gain in ELA and Math	3	30%
Performance Level Gain in ELA or Math and Improved Score in the Other Test	2	20%
Performance Level Gain in ELA or Math	2	20%
Score Increase in ELA or Math	2	20%
None	1	10%

Figure 9. 7<sup>th</sup> Grade Fall Cohort Gains on ILEARN

As the table in Figure 10 shows, 47% of the 8<sup>th</sup> grade students in the fall cohort improved their performance in ELA and/or Math on the annual ILEARN assessment.

ILEARN Gain	# of Students	% of Students
Performance Level Gain in ELA and Math	1	6%
Performance Level Gain in ELA or Math and Improved Score in the Other Test	0	
Performance Level Gain in ELA or Math	2	12%
Score Increase in ELA or Math	5	29%
None	9	53%

Figure 10. 8<sup>th</sup> Grade Fall Cohort Gains on ILEARN

## Conclusions

Urey Middle School implemented the cognitive assessment and training program with excellent fidelity to the recommended protocol and the students in the program experienced significant cognitive gains across all areas of the cognitive assessment, on average. The cognitive growth experienced by the students in this program was similar to cognitive growth in other effective implementations of BrainWare SAFARI using Mindprint and other cognitive assessments. <https://mybrainware.com/blog/category/research/>. Students who participated in the cognitive training program, especially those in the fall cohort, were able to translate their cognitive gains into improvements on academic performance measures, notably ILEARN, the Indiana state annual assessment.

The district decided to extend the program to 5<sup>th</sup> and 6<sup>th</sup> graders in its two elementary schools and to students in special education at the middle school level for the 2022-23 school year.