Research Report:
Arrowsmith Whole Cohort Program Outcomes

ARR⊕WSMITH

Arrowsmith Overview

In the human brain, networks of neurons are set up to perform particular cognitive functions such as: processing information; seeing relationships and making the connections necessary for insight and conceptualization; forming and retaining memories; navigating in space; recognizing familiar faces; parsing speech; learning motor plans for reading and writing; discriminating speech sounds; visually retaining symbol patterns necessary for reading, spelling and visual template learning; interpreting emotions; thinking non-verbally and planning, goal setting and strategic problem solving.

Enhancement of these cognitive functions that underlie learning in school and throughout life is possible through the targeted application of cognitive programs utilizing the principles of neuroplasticity. This is the basis of the Arrowsmith Program.

The Arrowsmith Program has helped thousands of people over the last 40+ years by using the principles of neuroplasticity to strengthen cognitive functions related to regions and networks of regions of the brain.

The Arrowsmith Whole Cohort Program

In the Whole Cohort Program all students in a grade work to enhance a specific cognitive function. A school may choose to have all grades working in this program or only selected grades. Arrowsmith has developed a sequence of developmentally appropriate cognitive exercises per grade based on the learning demands that occur in each grade. Students work 30 to 40 minutes per day five days per week on the specific cognitive program over the academic year.

With the opportunity to enhance a range of cognitive functions, students are able to develop the cognitive capacities necessary to understand and analyze complex abstract relationships, think critically, be flexible in thought, retain information and accept and consider other points of view. These are essential abilities required for all aspects of learning. Cognitive enhancement prepares students to be life-long learners.

Research

The research reported in this document was conducted at the schools implementing the Whole Cohort Program. For more information on the research measures used, See Appendix B: Research Measures Used.

Motor Symbol Sequencing and Symbol Relations Whole Cohort Research

Motor Symbol Sequencing is involved in motor planning necessary for writing and reading.

Symbol Relations is involved in understanding, comprehension, reasoning, and speed of processing ideas.

See the Appendix A: *Description of Cognitive Programs Implemented in these Studies* for a more detailed description of these cognitive functions.

Camperdown Academy, U.S.A.

Grade 2

In August 2014, Camperdown Academy in South Carolina was the first school to offer the Whole Cohort Program to all students in grade 2 in their school. The students worked on two cognitive programs, 40 minutes each per day five days per week over the academic year.

Whole Cohort Program – Grade 2

Motor Symbol Sequencing and Symbol Relations Cognitive Programs
Students Engaged in two 40-minute cognitive periods per day five days per week

Significant improvements in

Reading	Memory	Setting Goals
Spelling	Comprehension	Self-Organization
Writing	Attention	Planning

Students receiving the cognitive program in grade 2, when tested in grade 3 on a math accuracy test, out-performed the grade 4 and 5 students and demonstrated a significantly greater willingness to tackle more difficult math problems

Additional Data

Students receiving the cognitive program in grade 2, when tested in grade 3 on a math accuracy test, out-performed the grade 4 and 5 students and demonstrated a significantly greater willingness to tackle more difficult math problems.

The teacher implementing the program at Camperdown Academy commented, "There's something about Arrowsmith—it makes students excited to try something new." This work, by building cognitive resources gives students the capacity to be successful when trying something new.

Grades 3, 4, 5, 6

From 2018 to 2022, Camperdown provided the Symbol Relations cognitive program to all students in grades 3 to 6 for 40 minutes per day five days per week for a 90-day academic term. The CNS Vital Signs Neurocognitive Assessment was used to evaluate the cognitive changes in these students.

For these students, significant improvements were measured in the following cognitive domains:

- sustained attention
- cognitive flexibility
- processing speed
- executive function
- reasoning
- working memory

Whole Cohort Program – Grades 3, 4, 5, 6

Symbol Relations Cognitive Program

Significant gains in:

Sustained Attention	Processing Speed	Reasoning
Cognitive Flexibility	Executive Function	Working Memory

n = 95 students
48 students (2018) 47 students (2019)

Measured on CNS Vital Signs, a computerized neurocognitive assessment, 90 days after commencement of the Whole Cohort Program

Motor Symbol Sequencing Whole Cohort Research

Motor Symbol Sequencing is involved in motor planning necessary for writing and reading.

Public School, Australia

Grade 1

A public school in Australia implemented the Whole Cohort Program from February to November 2016 in one class of grade 1 students. These students worked 30 minutes per day, 5 days per week on the Motor Symbol Sequencing cognitive program. The other three grade one classes did regular writing programs as part of

their curriculum. There were 18 to 22 students per class. All students were tested at the beginning and end of the academic year on the WOLD Sentence Copy Test, a test measuring how quickly and accurately a student can copy printed material. The students in the class doing the Motor Symbol Sequencing cognitive program performed significantly better that the students in the three classes working on regular curriculum.

Additional Data

Five students had been identified in the previous academic year as being at risk for reading difficulties. All of these students were placed in the class doing the Motor Symbol Sequencing cognitive program. Ten weeks into the program, all of these students were de-identified as being at risk of developing reading problems. The Motor Symbol Sequencing cognitive program works on motor plans for writing and also for eye-tracking in reading, so the improvement in reading would be expected as the students improved in this cognitive function.

Whole Cohort Program – Grade 1

Comparison of results across four Grade One classes
- 3 classes: traditional writing program
- 1 class: 30 minutes/day doing the Arrowsmith exercise for learning motor plans necessary for writing and eye-tracking in reading (Motor Symbol Sequencing)

Classes	Arrowsmith Class		Gifted Class		Academic Class 1		Academic Class 2	
Students at or above grade level	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test
%	10%	95%	30%	70%	35%	45%	5%	45%
% Change		**85%**		**40%**		**10%**		**40%**

Results based on the WOLD Sentence Copy Test

At Risk Readers

- 5 students in the study were identified as at-risk for reading problems in kindergarten; Reading Recovery program recommended for Grade 1

- All 5 students were placed in **Arrowsmith** class in Grade 1

- After 10 weeks in the program, all 5 students were reading at proficient level and no longer recommended as needing Reading Recovery program

- Public School in Australia

Schools in Canada, Australia, and New Zealand

Grade 1

In the 2017 to 2018 academic year, three schools (Pickering Christian School, Canada; Darling Downs Christian School, Australia; and Finlayson Park School, New Zealand) all implemented the Motor Symbol Sequencing cognitive program in their grade one classes for 30 minutes per day five days per week.

The Children's Handwriting Evaluation Scale for Manuscript (CHES-M) was administered at the beginning and end of the academic year over an 8-month period. This measure evaluates two aspects of writing for students in grades 1 and 2 - writing speed/rate and quality of writing.

In all three schools, significant improvements were shown on both writing speed/rate and quality of writing using the Standard Score (SS) and the Percentile Score (%ile).
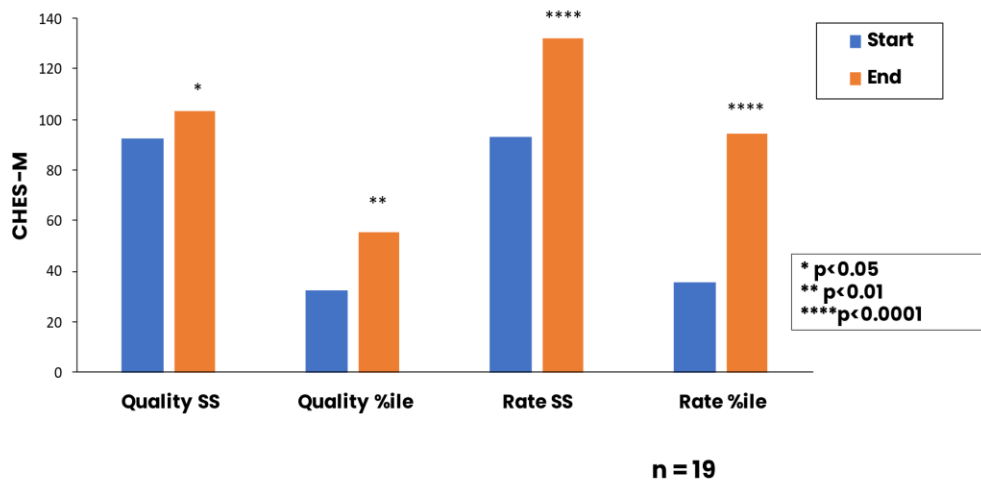
Whole Cohort Program – Grade 1
Motor Symbol Sequencing Cognitive Program– Pickering CS

*** p ≤0.001
****p<0.0001

n = 19
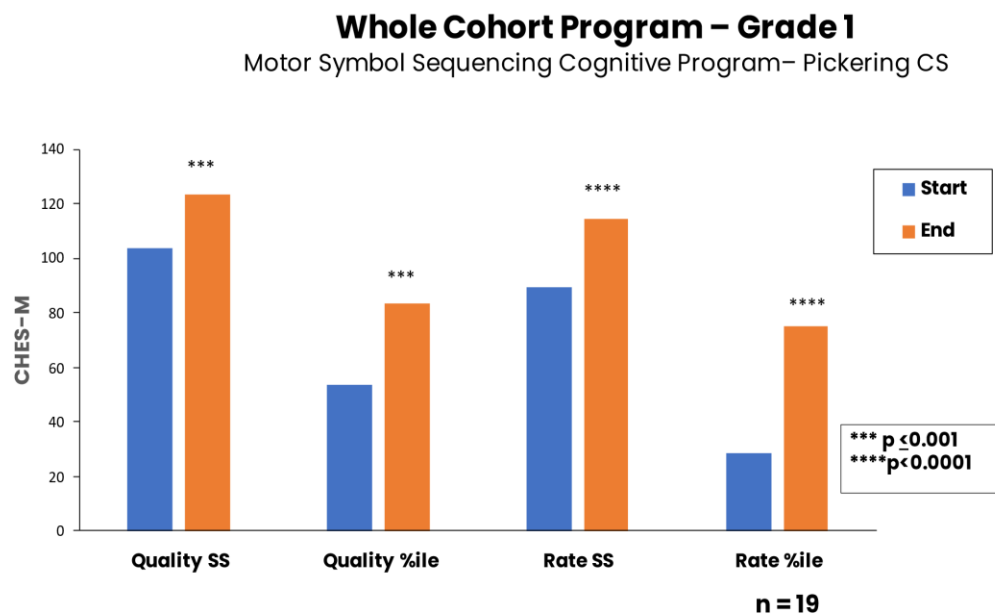
Whole Cohort Program – Grade 1
Motor Symbol Sequencing Cognitive Program– Darling Downs CS

Legend: Start (blue), End (orange)

** p<0.01
****p<0.0001

n = 23
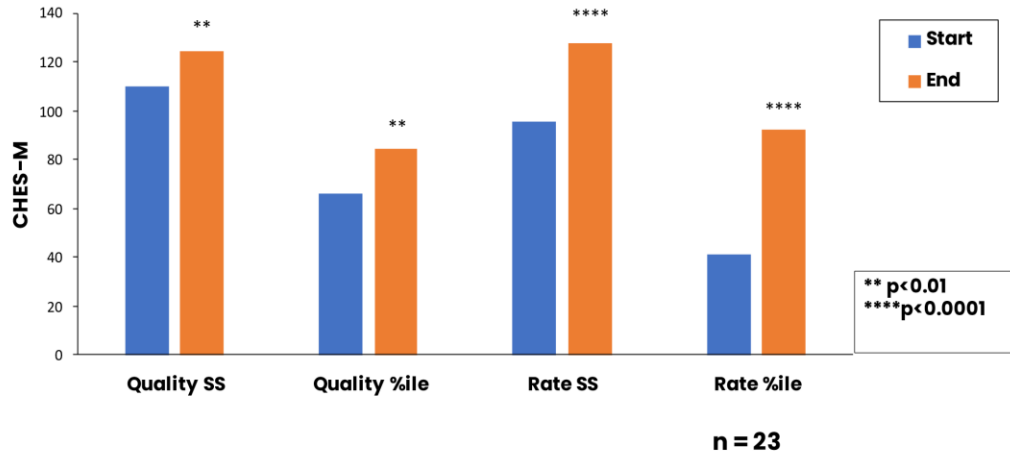
Whole Cohort Program – Grade 1
Motor Symbol Sequencing Cognitive Program– Finlayson Park School

Legend: Start (blue), End (orange)

* p<0.05
** p<0.01
****p<0.0001

n = 19

Symbol Relations Whole Cohort Research

Symbol Relations is involved in understanding, comprehension, reasoning, and speed of processing ideas.

SEK Schools, Madrid, Spain

All the research on the Whole Cohort Program at SEK St. Isabel has been conducted by Dr. Laura Herrero Perez and Dr. Miguel Angel Perez Nieto, Universidad Camilo Jose Cela.

Grade 3 – 2018

In January 2018, SEK St. Isabel School in Madrid Spain implemented the Symbol Relations cognitive program in their grade 3 class.
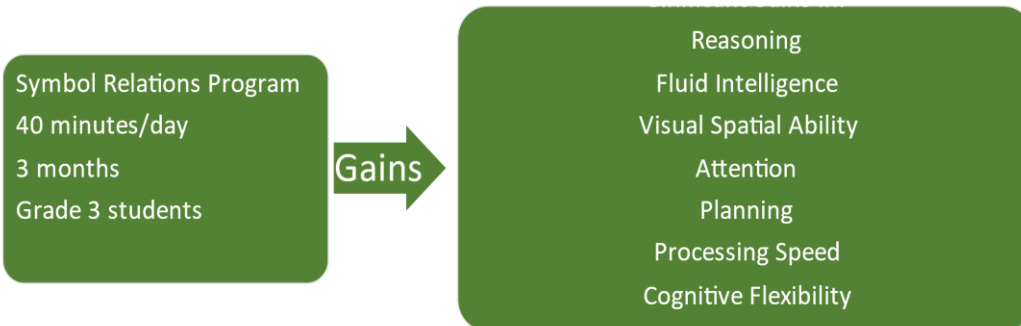
This group of students engaged in this cognitive program for 40 minutes per day five days per week over 3 months. There were 18 students in the class.

For the grade 3 students, significant improvements were measured in the following domains:

- abstract reasoning and fluid intelligence (Raven's Matrices)
- visuospatial abilities, attention, and planning (Rey Complex Figure Test; WISC Symbol Search and Coding)
- selective attention, concentration, processing speed, and endurance (Concentration Endurance Test (d2))
- processing speed (Trail Making Test; WISC Symbol Search)
- deductive reasoning skills and cognitive flexibility (Claves Test)

Whole Cohort – Grade 3
Symbol Relations Cognitive Program

Universidad Camilo José Cela

Symbol Relations Program
40 minutes/day
3 months
Grade 3 students

Gains →

Reasoning
Fluid Intelligence
Visual Spatial Ability
Attention
Planning
Processing Speed
Cognitive Flexibility

Research conducted by Dr. Laura Herrero Perez and Dr. Miguel Angel Perez Nieto
32nd International Congress of Psychology, Prague, July 2021

Presentation

Laura Herrero Perez, Cecilia Ines Theirs, Francisco David Pascal, and Miguel Perez Nieto. (2021, July). *Visuo-spatial ability improvements in typical development children involved in the Arrowsmith program* [Presentation]. 32nd International Conference of Psychology, Prague, Czech Republic.

Universidad Camilo Jose Cela Symbol Relations Whole Cohort Study 2021

Grade 3 – 2022

In January 2022 the Symbol Relations cognitive program was implemented in a grade 3 class at SEK St. Isabel.

This group of students engaged in this cognitive program for 40 minutes per day five days per week over 5 months. There were 41 students in the class engaged in the Arrowsmith cognitive program. There were 43 grade 3 students in two additional SEK Schools, matched for SES, who were engaged in regular curriculum (control group).

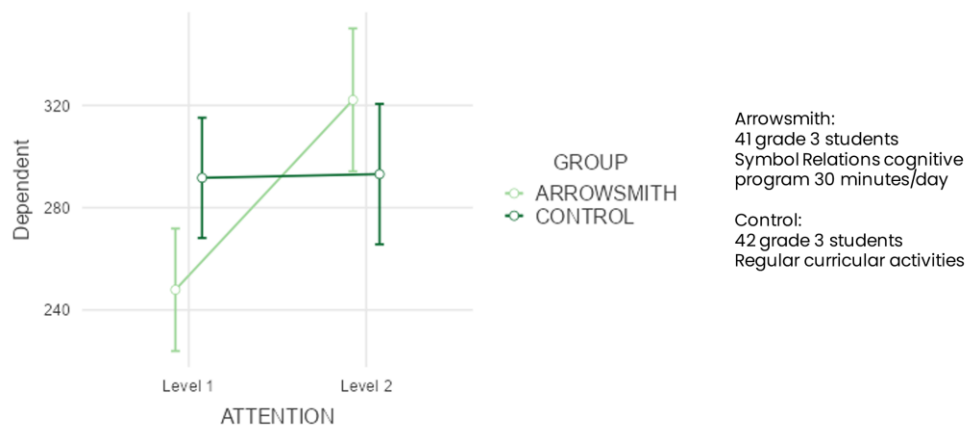For these grade 3 students, significant improvements were measured in the following domains:

- cognitive flexibility and working memory (Wisconsin Card Sorting Test)
- response inhibition (No Go Task)
- selective attention, concentration, processing speed, and endurance (Concentration Endurance Test (d2))

Universidad Camilo José Cela

Whole Cohort – Grade 3
Symbol Relations Cognitive Program
Selective Attention and Processing Speed

GROUP
ARROWSMITH
CONTROL

Arrowsmith:
41 grade 3 students
Symbol Relations cognitive program 30 minutes/day

Control:
42 grade 3 students
Regular curricular activities

Research conducted by Dr. Laura Herrero and Dr. Miguel Angel Perez, Universidad Camilo Jose Cela, Madrid Spain
Submitted for presentation at 23rd European Society for Cognitive Psychology Conference

Presentation

This research has been submitted for presentation at the 23rd European Society for Cognitive Psychology Conference, September 2023.

Conclusion

The Whole Cohort Program, implementing one cognitive program per grade for the Symbol Relations and Motor Symbol Sequencing cognitive programs, has shown to be effective in significantly enhancing a range of cognitive abilities that are critical for learning academically and in life. In the case of the Motor Symbol Sequencing cognitive program, foundational academic skills related to writing are improved.

Whole Cohort Program - Putting the Brain in the Education Equation

The crucial skills required for lifelong learning have been proposed by various educational think tanks, including the World Economic Forum and the Organization for Economic Co-Operation and Development (OECD).

WEF Ten 21st-century skills every student needs

OECD Future of Education and Skills 2030 (2019)

Both organizations recognize that education is more than the 3Rs and academic curriculum. They understand that students need critical skills to prepare them to function in the world of their future and for lifelong learning. Acquisition of these skills requires strong cognitive functioning.

The Whole Cohort Program has the ability to enhance cognitive functions and optimize cognitive capacity for students' future.

Whole Cohort Program Student Progress Compared to Student Progress in Full-Time and Part-Time Programs

The progress (levels mastered) and effort (amount of completed work) for students in mainstream classes engaged in Arrowsmith cognitive programs were compared to students identified as having learning disabilities in the Full-Time and Part-Time Arrowsmith cognitive programs. Both groups made significant positive progress while the Whole Cohort students in mainstream classes achieved higher levels of mastery with less effort than the students in the Full-Time and Part-Time Program who had learning disabilities. For the full report, read **Whole Cohort Progress Comparison Research Report**.

Additional Research

For additional research on the outcomes of the Arrowsmith cognitive programs see:
Arrowsmith Research

Appendix A: Description of Cognitive Programs Implemented in these Studies

Arrowsmith Symbol Relations Cognitive Program

The Arrowsmith Symbol Relations Task is a computer-based cognitive exercise consisting of a sustained visual-spatial processing task of progressively increasing difficulty. It requires students to use relational reasoning to conceptually and automatically process relationships that increase in complexity. Over the years, many research projects have been conducted with various cohorts of individuals, from those with learning difficulties/disabilities, traumatic brain injury, long COVID, addiction and those without learning challenges wishing to enhance performance.

The Symbol Relations cognitive function is involved in:

- cause and effect reasoning
- understanding the 'why' of things
- grasping concepts across all academic disciplines
- comprehension of what is read or heard
- making rational and considered decisions
- understanding the world, oneself, and others
- fluid reasoning and flexibility of thought
- logical grasp of mathematical concepts
- processing speed
- insight which is critical to the therapeutic process
- semantic grasp of language necessary for comprehension and
- vocabulary development
- perspective taking which involves the ability to consider other
- points of view necessary for empathy

If there is a difficulty in this cognitive function all of these processes are impacted.

Research on the Symbol Relations program outcomes for individuals with learning difficulties or learning disabilities has demonstrated significant improvements in:

- neural networks in the brain
- cognitive functioning
- acquisition of academic skills
- emotional intelligence and well-being

Arrowsmith Motor Symbol Sequencing Cognitive Program

The Arrowsmith Motor Symbol Sequencing task is a pencil and paper based cognitive exercise consisting of learning written motor plans of increasing complexity. This cognitive function is responsible for learning and producing motor plans involved in writing, reading and speech.

The Motor Symbol Sequencing cognitive function is involved in:

- automatic flow of ideas from one's mind into writing
- writing and copying material quickly and accurately
- legibility of writing
- completing timed written tests, assignments, homework, and projects within the allotted time
- spelling
- reading quickly and accurately
- spoken communication

If there is a difficulty in this cognitive function all of these processes are impacted.

Research on the Motor Symbol Sequencing program outcomes for individuals with learning difficulties or learning disabilities has demonstrated significant improvements in:

- written expression
- speed and accuracy of copying text
- legibility of handwriting
- writing speed
- reading speed

Appendix B: Research Measures Used

Motor Symbol Sequencing Whole Cohort Research

The Children's Handwriting Evaluation Scale for Manuscript (CHES-M)

WOLD Sentence Copying Test

Symbol Relations Whole Cohort Research

Claves Test

CNS Vital Signs

Concentration Endurance Test (d2)

Go No Go Task

Raven Progressive Matrices

Rey Complex Figure Test

Trail Making Test

WISC Symbol Search and Coding Subtests.

Wisconsin Card Sorting Test