ELAC). This was done in order to determine the residual of each student from this line. The residual is the distance that each Post score was, in a positive or negative direction, from the Post score predicted by the Pre score. A positive residual indicates that a student performed better than expected on the Post test after controlling for the Pre score, whereas a low residual indicates a student performed worse than expected. An ANOVA was conducted on the residuals, asking whether there is evidence for the programs differing in their mean residuals. There are only two significant results. In both the Comprehension (Comp) and Spelling tests, the Arrowsmith sample had significantly higher residuals than the ELAC sample (Comp: P = 0.002; Spelling: P = 0.012).

A similar method to examine the relationship between two numerical variables (i.e., Pre and Post scores) and whether there is an effect of a categorical variable (i.e., program) on that relationship is ANCOVA (Analysis of Covariance). This was conducted for the eight achievement test categories. For both Comprehension (Comp) and Spelling, there is a significant difference between the programs (with both having higher Post scores in Arrowsmith than ELAC; Comp: P=0.004; Spelling: P = 0.017). See graphs:





These were the only two statistically significant results from Siegel's study and are repeatedly observed by the two academic researchers consulted for their expertise. The scatter plots above for both Comprehension and Spelling show that Arrowsmith students tended to score higher on Post tests, after controlling for Pre test scores.

Dr. Darren Irwin stated in a written report that, "There is simply no evidence in the 2003 Report to justify the conclusion that 'On all but the Comprehension and Spelling measures, ELAC performed at higher levels than Arrowsmith, often by relatively large amount.' No statistical tests were used to justify this statement, and if they had been done, they would not have resulted in statistical significance" (2013).

#### 4. Additional Discussion on Arrowsmith Program student results -

The Arrowsmith Program is a three to four year cognitive intervention program designed to improve a wide range of learning disabilities. Thus, when the first year of a student's program is being designed, a wide range of cognitive weaknesses are taken into consideration and a specific group of exercises are recommended. A child may have reading, math, written expression, reasoning, language processing and social perception weaknesses and it can take up to three to four years to improve the cognitive functions related to all of these disabilities. The ten Arrowsmith students studied by Siegel were given four blocks per day, five days a week, of cognitive exercises during year one of the implementation

2002-2003. This is incorrectly noted in Siegel's report, where she indicated that the students received 5 blocks. These four blocks were filled with a variety of cognitive exercises designed to address language concerns (expressive and receptive language skills), written expression difficulties, executive functioning, reasoning weaknesses, visual memory and auditory memory. The Arrowsmith Program design implementation team did not focus on reading and writing achievement alone when creating Arrowsmith Programs for the ten students. This was not noted in Siegel's evaluation. In addition, some of the ten AP students received no reading instruction over the course of the year and none of this group received math instruction during that academic year (2002-2003). This goes against the recommendation of the Arrowsmith Program.

Despite all of these methodological limitations (i.e., student group demographics and Arrowsmith programming theory), it was still possible to detect differential improvements in the Arrowsmith Program students on two measures of achievement (Comprehension and Spelling). That is, the Arrowsmith Program study sample, even with some students not receiving reading instruction, showed more gains than those students who were in a class primarily focused on that goal.

As noted previously, based on data with two discrepant values, Siegel concludes that:

"On all but the Comprehension and Spelling measures, ELAC performed at higher levels than Arrowsmith, often by a relatively large amount. This provides support for the relative success of [Nootka] ELAC" (Siegel, 2003).

What is interesting about this conclusion is Siegel's comment ten years later in the LDA Australia Bulletin (2012). Siegel writes, "The children in both classes were assessed before and after the program on a variety of reading spelling and mathematics tests. I found that there was very little improvement in the children's academic skills in either class."

#### **Conclusion:**

It is difficult to understand, given Siegel's study's severe limitations, how she can continue to use this as research evidence that the Arrowsmith Program is not effective. Instead, despite the low statistical power associated with this small sample, and despite its many methodological flaws, the data indicates a greater improvement on average in the Arrowsmith Program sample in two of the eight achievement tests. This should have been the conclusion of Siegel's study. To reject a potentially effective intervention based on such a flawed analysis is irresponsible and does a great disservice to students who might benefit from this cognitive intervention. This is especially the case for children in the Vancouver School Board (VSB) who cannot afford the program if it is only accessible through a private school. The Vancouver Foundation provided a three year grant to pilot the Arrowsmith Program. The VSB decided to discontinue the program after year two and it was noted by Val Overgaard in written communication to Howard Eaton that Siegel's research was influential in that decision making.

Dr. Darren Irwin notes in his review of Siegel's study, "The 2003 report has a variety of serious methodological, calculation, and statistical problems, and most importantly its conclusion of 'support for the relative success of ELAC' does not follow from the data. Given the inconsistencies regarding correct Post scores in two cases, and given concerns regarding whether there may be confounding factors that affect the results, we should be cautious of making any strong conclusions regarding the relative effects of the two programs based on the 2003 study. Nonetheless, a proper analysis of the raw data as presented (based on a comparison of the residuals of a regression of Post scores on Pre scores, and backed up by an ANCOVA) reveals that two tests (Comp and Spelling) showed statistically significant differences between the programs, and both of these differences were in the direction of Arrowsmith having higher Post scores than ELAC, after controlling for Pre scores. I emphasize that the only significant differences between the programs were in the direction of Arrowsmith. Given the problems mentioned above regarding the comparability of the two groups of students, these statistically significant results should be taken not as a certain result but rather as strong observational evidence that Arrowsmith may in fact be more effective than ELAC. I recommend however that this be taken as a provisional hypothesis until stronger studies can be designed and conducted."

The other point, and likely most significant, is that the Arrowsmith Program takes three to four *years* to fully complete. This is an 8 month study. A second year was completed with the Arrowsmith Program students, but no data was reported. In addition, the Arrowsmith Program addresses a multitude of cognitive weaknesses that affect children with learning disabilities, not just in areas of achievement. The Arrowsmith Program students in Siegel's study were not just given cognitive exercises related to achievement, but also to reasoning, language processing, motor output for written expression, executive functioning, visual memory and auditory memory. These cognitive abilities should have been measured in this study. In fact, it was noted by Siegel that the students received cognitive testing (Woodcock Johnson III Cognitive Tests), but no results (Pre and Post) were noted in her study. This data is missing.

#### **Discussion:**

It is the view of this author that Siegel's research does not qualify as an acceptable evaluation of the Arrowsmith Program. This data should never have been used or presented to Val Overgaard, Associate Superintendent, Learning Services, Vancouver School Board (VSB) as evidence of program effectiveness for children with learning disabilities. Siegel, based on her letter to the Learning Disabilities Association of Ontario dated October 23, 2001, should agree with this fact, given that her exact recommendations made only ten months prior to the start of this research were not personally followed in the Vancouver School Board study. In fact, it is my opinion that no journal would have published such research. The VSB's intent for this research was to evaluate two programs for children with identified learning disabilities; however, the majority of the Arrowsmith Program students were not identified (70%) as having a learning disability.

There also appears to be a fundamental lack of knowledge regarding the theory behind the use of the Arrowsmith Program among some educators. The primary goal of the Arrowsmith Program is to improve cognitive functioning in a variety of brain areas and networks. The theory holds that without these cognitive functions it is very difficult for children to learn effectively – whether it is functioning in a classroom (listening, speaking, copying) or acquiring reading, math, written language or general knowledge (Social Studies, Science, etc.). The question then becomes - are these cognitive functions fixed and unchangeable or can they be improved upon? Siegel's evaluation for the Vancouver School Board did not include measures of cognitive ability, although she reports that tests of cognitive ability were given to the students in her study.

Currently, in the field of Learning Disabilities, those working with students with learning disabilities are attempting to work around these students' cognitive weaknesses (i.e., through strategy instruction, technology, accommodations, course exemptions). The assumption is that these neurological weaknesses are fixed and unchangeable. This assumption in the field of Learning Disabilities is evident when one looks at the definitions of a learning disability put forward by national associations dedicated to this disability. Often, definitions of learning disabilities highlight that they are life-long. The work of the Arrowsmith Program puts this statement in doubt. If learning disabilities are caused by neurological weaknesses, and neurological weaknesses can be strengthened (neuroplasticity), does it not hold that it is possible to reduce the severity of a learning disability through cognitive training? The concept of neuroplasticity is one that should be applied to the field of Learning Disabilities. This is what the Arrowsmith Program has been doing for over 30 years.

The field of Education is not fully embracing the field of Neuroscience. The field of Neuroscience is what the Arrowsmith Program is based upon both in theory and in practice. This, I believe, is the real issue. Certainly, given my review of this research presented to the Vancouver School Board, there is actually no evidence that the Arrowsmith Program did not improve the cognitive capacities of the children studied. The focus of the Arrowsmith Program is on improving cognitive functioning. Once this improves, learning then becomes more effective, whether it is learning to read, learning to write, or understanding math. Siegel states that she conducted measures of cognitive functioning on the two groups studied in her research, but no data was reported as to their progress in these areas (Siegel, 2003). The only area focused upon in her report was academic achievement. Again, this is often the focus of educators.

The Arrowsmith Program fully recognizes and agrees with the need to teach reading, writing, spelling and math to children with learning disabilities. The work on phonological awareness and the teaching of decoding skills is required for effective treatment of such disabilities as Dyslexia. Nevertheless, over the last 30 years, the Arrowsmith Program has observed through careful assessment and data collection that some children with Dyslexia or other forms of Learning Disabilities do not respond to achievement based remediation. The Arrowsmith Program has discovered that this is often due to one or both of two reasons. First, the level of severity of the cognitive weaknesses required for reading acquisition (i.e., severe auditory processing or visual memory weaknesses) interferes with the ability of the achievementbased intervention to work effectively. Second, the number of cognitive weaknesses related to reading, writing or spelling hinders progress (i.e., cognitive weaknesses in auditory, visual, visual-motor, reasoning and language areas of the brain).

The question comes back to the relationship between educational researchers and neuroscientists conducting research. Can they work together, with respect, and with high levels of research integrity? Is it possible for them to be conscious of their paradigm and how it influences their behaviour or judgement? Are they willing not to pass judgement unless there is peer-reviewed and cross-discipline research published? I am concerned that this is going to be a challenge for some. For some educators, even the notion that neuroscience has anything to offer their field is at question.

In 2012, Barbara Arrowsmith Young was touring Australia promoting her book, "The Woman Who Changed Her Brain" (2012). As news of this tour became public, various academics wrote position statements on neuroscience and the work of Barbara Arrowsmith Young in several on-line publications. In particular, a website called "The Conversation", was used by Siegel's fellow reading researchers to comment on the Arrowsmith Program.

One reading researcher, Max Coltheart (Emeritus Professor, Department of Cognitive Science, Macquarie University, Australia), wrote an article for an online publication (Coltheart, 2012). He wrote, "This excitement around 'brain-based learning' – as if learning could occur anywhere else – and 'neuroplasticity' is irrelevant at best, and at worst has been a major distraction without any practical meaning for educators." If this is the fundamental belief system of these researchers, the Arrowsmith Program has no chance for fair and just research.

Coltheart colleagues at Macquarie University, Anne Castles and Genevieve McArthur, also wrote a paper in The Conversation (Australia) when they heard of the interest in the Arrowsmith Program among educators and the public. In their paper they wrote, "According to Arrowsmith, the program can be 'thought of as a type of mental work out for the brain' in which 'underfunctioning areas are treated like weak muscles and are intensely stimulated through cognitive exercises'. This is rather an odd idea given that the brain is 'working out' all the time – constantly receiving, analysing and responding to masses of stimuli. Reading the paper, walking down the street, chatting to a friend – all of these involve an enormous number of complex neural processes. The brain is hardly sitting on the couch, watching TV and eating chips. The idea that the brain needs a mental workout doesn't hold much water when we know the brain is working out pretty hard every waking (and even sleeping) moment" (Castles & McArthur, 2012). This quote outlines a lack of awareness of neuroscience findings on how the brain changes and how this could benefit education. In fact, there are specific behaviour requirements required to significantly and meaningfully change brain function and these do not include chatting to a friend or walking down the street.

Finally, why do these academics speak so harshly of neuroscience and the Arrowsmith Program? Why, without any scientific evidence that the Arrowsmith Program is not working to improve the cognitive functions of children with learning disabilities, do these academics use words such as "odd idea" (Castles & McArthur, 2012) and "hype" (Siegel, LDA Australia Bulletin, 2012). Clearly, these academics know Siegel, and she was invited to receive an award from the Learning Difficulties Association of Australia.

The influence of Siegel's study and conclusions cannot be underestimated. For example, an article on cognitive intervention was written by Ingrid Wickelgren, Editor, Scientific American Mind in the May/June 2013 issue. Ms. Wickelgren, referring to the Arrowsmith Program wrote, "Indeed, one small eight – month investigation of the school's curriculum led by educational psychologist Siegel of the University of British Columbia failed to show that it significantly improved students' scores on a battery of cognitive and achievement tests" (Wickelgren, 2013, p. 45). Based on the statistical analysis shown in this review this statement is not true and could wrongly dissuade educators from adopting the Arrowsmith Program. First, no measures of cognitive ability (Pre and Post) were shown in the evaluation. Second, the only statistically significant finding was in favor of the Arrowsmith Program on two measures of achievement (Comprehension and Spelling).

It is good to see other researchers understanding that cognitive intervention for children with learning disabilities has merit and deserves more research. A recent article in Exceptional Children, by Devin Kearns of Boston University and Douglas Fuchs of Peabody College, Vanderbilt University entitled, "Does Cognitively Focused Instruction Improve the Academic Performance of Low-Achieving Students?", concludes:

"An obvious conclusion from our review is that cognitively focused instruction, in the main, is still early in its development. Few cognitively focused programs have been explored by researchers in sufficient numbers and with appropriate experimental control to warrant an endorsement as evidence-based practices. And yet, we believe we would be misrepresenting this literature if we were to say that findings justify an out-of-hand, or conclusive, dismissal of such an approach. We wish to see a greater number of intervention researchers take cognitively focused instruction seriously, and we have two reasons for this. First, the evidence suggests it may have potential. Second, there is indisputable need for alternative methods of instruction for the 2% to 6% (cf. Wanzek & Vaughn, 2009) of the general student population for whom academic instruction—including DI-inspired skills-based instruction—is ineffective. The plight of these children and youth should challenge educational researchers to develop instructional programs and curricula that are imaginative in design and application and empirically validated for those for whom they are intended" (Fuchs & Kearns, 2013, p. 285).

The Arrowsmith Program is excited about conducting high quality research. The question is who should conduct this research? Over the last few years, the Arrowsmith Program has been searching for researchers who are not biased or who do not feel the need to hold onto other paradigms. It is clear, given the evidence noted previously, that the Arrowsmith Program has to be discerning as to which researcher or research team is chosen. Several research projects are currently being discussed with universities in North America. The Arrowsmith Program has already conducted its own research that will

help inform ongoing independent research. This can be viewed at the Arrowsmith School website. The Arrowsmith Program looks forward to years of ongoing educational and neuroscientific evaluation to help advance the field of Learning Disabilities.

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A copy of the 2003 report by Siegel is available by email. Please send your request to <u>info@eatonarrowsmithschool.com</u> or <u>info@arrowsmithprogram.ca</u>.

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### Annexure Q

# Academic Skills and Learning Outcomes



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### How the Arrowsmith Program Cognitive Exercises Address Learning Difficulties

The Arrowsmith Program is based on the application of neuroscience research and the premise that it is possible to address a range of specific learning difficulties by identifying and strengthening cognitive capacities.

The Arrowsmith Program, through careful assessment, identifies areas of learning strength and weakness to create an individual learning profile for each student and then designs a program of individualized exercises to target the precise areas of weakness.

The goal of the Arrowsmith Program's intensive and graduated cognitive exercises is to strengthen a range of weak cognitive capacities that are hypothesized to underlie a number of specific learning difficulties.

The Arrowsmith Program Chart of Learning Dysfunctions and Learning Outcomes, on the website and in this document, provides a description of the relationship between the function of the cognitive areas for which the Arrowsmith Program has developed specific targeted programs, the learning difficulties a student may have if there is a problem in this function, and the learning outcomes achieved related to the cognitive function upon completion of the Arrowsmith Program.

There have been a number of research studies, discussed later in this document, that have demonstrated a range of improvements in Arrowsmith Program students. Using different research designs, different measures, both educational and cognitive, and studying students in different schools implementing the Arrowsmith Program, the studies show improved academic performance and learning abilities. For updates on the research being conducted on the Arrowsmith Program, please visit the *Research page* on the website.

The goal of the Arrowsmith Program is to strengthen the learner's ability to learn through a range of specific programs so that learning can proceed efficiently and effectively, significantly reducing or removing the need for compensations or modifications. The goal is for students to become effective, confident and self-directed learners for life and to enable them to achieve their goals of academic and career success.

# Chart of Learning Dysfunctions and Learning Outcomes

Cognitive Area	Description of Cognitive Function	Common Features if there is a Problem in this Area	Learning Outcomes
Motor Symbol Sequencing	Ability to learn and produce a written sequence of symbols	Messy handwriting, miscopying, irregular spelling, speech rambling, careless written errors in mathematics, poor written performance	Improve handwriting; reduce careless errors in written work; develop fine motor skills, sequential motor memory and motor planning in writing, capacity for hand-eye coordination
Symbol Relations	Ability to understand the relationships among two or more ideas or concepts	Difficulty with reading comprehension, trouble with mathematical reasoning, trouble with logical reasoning, difficulty reading an analog clock, problem understanding cause and effect, reversals of 'b'-'d'; 'p'-'q'(younger students and in more severe cases)	Develop ability to read a clock; improve capacity necessary for understanding relationships between concepts necessary for logical and mathematical reasoning and reading comprehension that affect all aspects of curriculum and life
Memory for Information/ Instructions	Ability to remember chunks of auditory information	Trouble remembering oral instructions, difficulty following lectures or extended conversations, problem acquiring information through listening	Develop auditory memory and the capacity to remember and follow oral instructions and retain information for learning; improve the capacity to remember chunks of information
Predicative Speech	Ability to see how words and numbers interconnect sequentially into fluent sentences and procedures	Problem putting information into one's own words, speaking in incomplete sentences, difficulty using internal speech to work out consequences, trouble following long sentences, breakdown of steps in mathematical procedures	Improve the capacity to understand a sentence of increasing difficulty and length; improve the ability to put information into own words; develop the capacity for the sense of how symbols (words and numbers) interconnect sequentially; improve the ability to follow procedures in mathematics; develop the ability to write and speak in complete sentences
Broca's Speech Pronunciation	Ability to learn to pronounce syllables and then integrate them into the stable and consistent pronunciation of a word	Mispronouncing words, avoiding using words because of uncertainty of pronunciation, limited ability to learn and use phonics, difficulty learning foreign languages, difficulty thinking and talking at the same time, flat and monotone speech with lack of rhythm and intonation	Develop/improve the capacity for sound-symbol correspondence; develop the phonemic memory necessary for the phonetic aspect of reading; develop the ability to pronounce multisyllabic words correctly; develop the ability to read with greater oral expression

Cognitive Area	Description of Cognitive Function	Common Features if there is a Problem in this Area	Learning Outcomes
Symbolic Thinking	Ability to develop and maintain plans and strategies through the use of language	Problem being self-directed and self-organized in learning, limited mental initiative, difficulty keeping attention relevantly oriented to the demands of a task necessary for completion, difficulty thinking, planning, problem solving, trouble seeing the main point	Develop/improve the ability to grasp the main point of written or orally presented material; develop the ability to state the main idea of a selection using one's own words; develop the ability to maintain plans and strategies for problem solving; develop the capacity to express ideas more clearly in writing; develop the capacity to self-direct, to develop initiative and to remain focused on tasks to completion
Symbol Recognition	Ability to visually recognize and remember a word or symbol	Poor word recognition, slow reading, difficulty with spelling, trouble remembering symbol patterns such as mathematical or chemical equations	Develop/improve the capacity to visually recognize and remember words or symbols necessary for reading, spelling and mathematics
Lexical Memory	Ability to remember several unrelated words	Problems with associative memory, trouble following auditory information, trouble learning names of things such as animals, places, people, colors, days of the week	Improve vocabulary development and auditory memory for words
Artifactual Thinking	Ability to register and interpret non-verbal information and plan and problem solve non-verbally	Problems interpreting non- verbal information such as body language, facial expression and voice tone, weak social skills, difficulty perceiving and interpreting one's own emotions, difficulty thinking, planning, problem solving non-verbally	Develop the capacity for non-verbal thinking and problem-solving; develop the ability to interpret body language, facial expression and voice tone and to respond appropriately in interpersonal interactions; develop ability to interpret and modulate his/her own emotions
Quantification Sense	Ability to carry out internal sequential mental operations, such as mental mathematics	Finger counting, trouble retaining numbers in one's head, difficulty making change, problem learning math facts, poor sense of time management, difficulty with time signature in music	Develop the capacity for number sense; develop the capacity for carrying out internal sequential, mental computation of addition and subtraction; develop the ability to use time wisely through scheduling and organization; develop an understanding of quantification related to money, time, space

## Studies Demonstrating Arrowsmith Program Outcomes and Acquisition of Academic Skills

There have been a number of studies that have demonstrated improvements in students' academic skills upon completion of the Arrowsmith Program. It is hypothesized that increased cognitive capacities have enabled students to acquire these academic skills.

Overviews of some of the studies and highlights of the key findings are outlined below.

#### A Report on the Effectiveness of the Arrowsmith Program in the Toronto Catholic District School Board, January 2007

This report, prepared from data gathered by teachers in the Toronto Catholic District School Board (TCDSB) on students enrolled in the Arrowsmith Program between 1997-2007 in the TCDSB, demonstrated that the students' rate of learning on specific academic tasks (word recognition, arithmetic, reading comprehension and reading speed) increased by 1.5 to 3 times the rate they were learning at prior to the Arrowsmith Program.

The study noted:

"Specific changes were also noted in cognitive functioning in the areas of: visual memory; auditory memory; logical reasoning; non-verbal problem solving; concentration and focus; number sense; thinking and problem solving; conceptual understanding; and comprehension. The changes in the student's cognitive capacities led to the increased rate of learning in academic areas."

**Report on an Outcome Evaluation of the Arrowsmith Program for Treating Learning Disabled Students,** prepared by Dr. William Lancee, November 2005

This study followed students at Arrowsmith School over three years and concluded:

"The study, combined with previous research of the program, strongly supports the effectiveness of the Arrowsmith Program for a wide spectrum of learning problems. These results provide hope for parents and teachers, and open up opportunities for children struggling with learning difficulties."

**Report on the Toronto Catholic District School Board (TCDSB) Study of the Arrowsmith Program for Learning Disabilities,** prepared by Dr. William Lancee, January 22, 2003

A research study comparing students enrolled in the Arrowsmith Program (AP) with students in a traditional special education program that was conducted over the 2001/2002 school year in the Toronto Catholic District School Board.

The study concludes:

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"Despite some study design limitations and small sample size, the study results strongly support the Arrowsmith Program as instrumental in changing the developmental course of the majority of children with learning disabilities (LD) in this sample. In only 12 months, almost one third of the AP students were on a course that brought them closer to their peers. Another 27% improved their performance at the same rate as expected from their non-LD peers, that is, they stayed at the same distance but did not fall further behind. All other AP students (43%) improved at least somewhat on the various achievement tests. None of the 10 students in the comparison group progressed substantially beyond their entry status."

## Changes Observed on Cognitive Measures of Arrowsmith Program Students at Eaton Arrowsmith School (EAS) 2005-2008 and Eaton Learning Centre (ELC) 1999-2004 prepared by Howard Eaton, Ed.M.

Documentation of significant score changes on a number of standardized psycho-educational assessments of students in the Arrowsmith Program at Arrowsmith School Toronto administered by the Eaton Learning Centre in Vancouver, and with students at Eaton Arrowsmith School in Vancouver.

Students demonstrated significant gains after time spent in the Arrowsmith Program on measures that are directly related to learning skills, cognitive functioning and academic outcomes such as: cognitive efficiency, working memory, visual motor integration, visual perceptual functioning, auditory processing for speech sounds, semantic knowledge, and achievement skills.

**Treatment Outcome for a Motor Symbol Sequencing Dysfunction** Barbara A. Young, M.A. & Donald F. Burrill, Ph.D. Poster Session - 2000 APA Annual Convention, Washington D.C., August 7, 2000

This study investigated the relationship between a treatment program designed to train automatic written motor symbol sequences for a group of 12 learning disabled individuals having difficulty with the writing process and outcome measures on a test developed to measure the rate of learning a repeated sequence of symbols as an automatic motor pattern and standardized tests of writing and copying.

Significant positive changes were found from pre- to post-treatment testing on all measures.

The study concludes:

"...for individuals identified as having certain specific difficulties with the writing process, the treatment program described in this paper improved subjects' performance on tests of learning a symbol sequence, clerical speed and accuracy, handwriting, and copying."

Summaries of the above noted studies are detailed below, and complete copies of the studies can be found on our website at: http://www.arrowsmithschool.org/arrowsmithprogram-background/research.html

### Summary of Studies Showing Transfer to Academic Skills

Study Name	Description of Study	Summary of Outcomes			
Report on the Arrowsmith Program in the Toronto Catholic District School Board (TCDSB) January 25, 2007	A follow-up study tracking progress of students in the Arrowsmith Program in the TCDSB on standardized achievement measures and	A. Increase in Academic Skills Increase in rate of acquisition of academic skills measured by average grade gain per school year, after 1 year of Arrowsmith Program (AP)			
	the amount of resource support needed pre and post Arrowsmith Program.	Academic Measure	Pre-Arrowsmith	After 1 Year in Arrowsmith	
	Reports from parents, teachers and students of specific	Word Recognition (WRAT)	0.6 grade per year	1.9 grades per year	
	observable cognitive and academic gains.	Arithmetic (WRAT)	0.6 grade per year	1.5 grades per year	
	Reports from teachers, students and parents re:	Reading Comprehension (Monroe-Sherman)	0.6 grade per year	1.8 grades per year	
	success of TCDSB Arrowsmith students in high school and	Reading Speed (Monroe-Sherman)	0.6 grade per year	2.0 grades per year	
	post secondary programs.	B. Reduction in Resource Support Significant reduction in amount of resource support required (measured by % of students requiring support)			
		Amount of Resource Support Required	Pre - Arrowsmith	Post - Arrowsmith	
		No Support Periods	0 %	69 %	
		1 - 2 Periods	55 %	26 %*	
		4 -8 Periods	45 %	5 %	
		*Post-Arrowsmith, no student required 2 periods of resource support. This category on follow-up reflects the range from 1 period of resource support to occasional use of a resource classroom for completing homework or writing exams.			
		C. Parent, Student, Teac Significant changes in factual information; do instructions and ideas skills such as reading, reason logically; do m verbally; think and pro visual symbol patterns achieve higher grade s Confidence levels and levels were reduced.	cher Ratings students' ability to b homework indep s; listen; organize t , writing, spelling, f ental arithmetic; p oblem solve in lang s required for read scores in their aca d self-esteem impr	o: focus; remember endently; understand hemselves; acquire telling time, numeracy; roblem solve non- juage; remember ing and spelling; demic classes. oved and frustration	

This report can be downloaded as a pdf document at:

http://www.arrowsmithschool.org/arrowsmithprogram-background/research.html

Arrowsmith PROGRAM®



Study Name	Description of Study	Summary of O	utcomes		
Report on an Outcome Evaluation of the Arrowsmith Program for Trogting Learning	A three year outcome study of 79 children with learning disabilities conducted at Arrowsmith School funded by the Canadian Donner	A. Increase in Academic Achievement in Areas of Weak Performance Study found that on average Arrowsmith students' performance on a composite of 6 academic achievement test scores moved from below average to average range			
Disabled Students	A number of standardized		Composite Acade	emic Performance	Score (Percentile)
November 20,	measures were used such as achievement tests and tests of mental ability as well as	Severity of LD	Year 1 Gain	End of Year 2	End of Year 3
2003	measures of learning capacity and changes in rates of learning. Study undertaken by Dr. William J. Lancee, Head of Research in the Department of Psychiatry at Mount Sinai Hospital and Associate Professor, Department of Psychiatry, University of Toronto.	Mild	14 - 41 %tile	47 %tile	48 %tile
		Moderate	11 - 23 %tile	31 %tile	35 %tile
		Severe	6 - 15 %tile	21 %tile	27 %tile
		B. Correlation between Increased Academic Achievement and Improvements in AP Cognitive Functions			
		Improvement in specific AP cognitive function was correlated change in achievement tests related to that AP cognitive fur (for example improvement in symbol recognition was related to improvement on the following achievement tests – cross out letters, vocabulary, visual letter memory, word recogniti spelling, word attack – and all of these changes would be expected given improved visual symbol memory).			

This report can be downloaded as a pdf document at: http://www.arrowsmithschool.org/arrowsmithprogram-background/research.html

Study Name	Description of Study	Summary of Outcomes		
Report on the Toronto CatholicA one-year study comparing outcome measures (on 10 standardized academic achievement tests and 2 standardized tests of intelligence) of 30 grade 2 to grade 7 students enrolled in	A one-year study comparing outcome measures (on 10 standardized academic achievement tests and	Study results strongly support the Arrowsmith Program as instrumental in changing the developmental course of the majority of children with learning disabilities (LD) in this sample.		
	After 12 months of Arrowsmith Program (AP) cognitive exercises 100% of the AP students showed improved academic performance.			
Learning Disabilities	the Arrowsmith Program from 4 schools in the TCDSB to 10 students in a traditional	the Arrowsmith Program from 4 schools in the TCDSB to 10 students in a traditional	the Arrowsmith Program from 4 schools in the TCDSB to 10 students in a traditional	<ul> <li>30% of the AP students were on a course of accelerated academic achievement that brought them closer to their non- LD peers.</li> </ul>
January 22, 2003	for students with learning disabilities. Study by Dr.	• Another 27% improved their performance at the same rate as their non-LD peers.		
William J. Lancee	William J. Lancee	• All other AP students (43%) showed some improvement on the achievement tests.		
		<ul> <li>None of the 10 students in the traditional special education classroom comparison group progressed substantially beyond their entry status.</li> </ul>		
	<ul> <li>Improvements were reported in more than 80% of AP students in the following areas: reading comprehension; ability to focus on task; understanding ideas; legibility of written work; confidence; self-esteem; ability to self- advocate, and between 70% and 80% of students in: telling time; remembering factual information; listening skills; organizational skills; and understanding and following instructions.</li> </ul>			
		• For AP students, improved comprehension as observed by teachers in class correlated highly with the relative progress grade equivalent (GE) score which was measured by the change in the GE score over the year averaged over 5 academic achievement tests (Pearson r = 0.49; p<0.01).		

This report can be downloaded as a pdf document at: http://www.arrowsmithschool.org/arrowsmithprogram-background/research.html



## Summary of Studies Showing Improvement on Cognitive Measures

Study Name	Description of Study	Summary of Outcomes			
Eaton Arrowsmith School (EAS) Changes Observed on Cognitive Scores	Changes on a number of standardized Psycho- Educational Assessment tests of students in the Arrowsmith Program at Eaton Arrowsmith School These results are detailed	12 year old Boy- 2 years in Arrowsmith Program			
		Performance Test	Pre-Arrowsmith	After 2 Years in Arrowsmith	
		Coding Subtest WISC-III (before) WISC-IV (after)	5 %tile	75 %tile	
of Arrowsmith Program Students at Eaton		Working Memory WISC-III (before) WISC-IV (after)	12 %tile	50 %tile	
Arrowsmith	- Stories of Children with	Verbal Ability WJ-III	67 %tile	94 %tile	
School	Learning Disabilities and	Visual-Auditory Learning WJ-III	20 %tile	47 %tile	
2005-2008	Attention Disorders Who Changed Their Lives By	Motor Coordination BEERY	7 %tile	53 %tile	
2003-2000	Improving Their Cognitive	Non-Verbal Intelligence TONI-3	50 %tile	88 %tile	
	Functioning by Howard Eaton, Ed.M.	12 year old Boy - 2.5 years in Arr	rowsmith Progra	ım	
	Note: Source of data in order of Chart: Table 24, page 192; Table 5, page 80; and Table 15, page130 in <b>Brain School</b> by Howard Eaton, Ed.M.	Performance Test	Pre-Arrowsmith	After 2.5 Years in Arrowsmith	
		Visual-Motor Integration BEERY	45 %tile	92 %tile	
		Processing Speed WISC-III (before) WISC-IV (after)	12 %tile	34 %tile	
		Auditory Processing: WJ-R (before) Phonemic Awareness WJ-III (after	38 %tile	85 %tile	
		Applied Math Problems WJ-R (before) WJ-III (after)	16 %tile	31 %tile	
		Fluid Reasoning: WJ-R (before) Concept Formation: WJ-III (after)	5 %tile	64 %tile	
		Non-Verbal Intelligence TONI-3	34 %tile	91 %tile	
		13 year old Girl - 3 years in Arrowsmith Program			
		Performance Test	Pre-Arrowsmith	After 3 Years in Arrowsmith	
		Cognitive Efficiency WJ-III	6 %tile	65 %tile	
		Coding Subtest WISC-III (before) WISC-IV (after)	25 %tile	95 %tile	
		Thinking Ability WJ-III	56 %tile	91 %tile	
		Working Memory WJ-III	17 %tile	51 %tile	
		Visual-Auditory Learning WJ-III	3 %tile	67 %tile	
		Non-Verbal Intelligence TONI-3	32 %tile	94 %tile	

Study Name	Description of Study	Summary of Outcomes			
Eaton Learning Centre (ELC)	Changes on a number of standardized psycho- educational assessment tests of students in the Arrowsmith	18 year old Girl - 1 year in Arrowsmith Program			
Changes		Test	Pre-Arrowsmith	After 1 Year in Arrowsmith	
Cognitive Scores	Toronto administered by Eaton	Writing Fluency WJ-III	2 %tile	53 %tile	
of Arrowsmith	Learning Centre in Vancouver.	Math Fluency WJ-III	28 %tile	75 %tile	
Program Students	These results have been	Visual Auditory Learning WJ-III	4 %tile	61 %tile	
1999-2004	replicated with students at	Cognitive Efficiency WJ-III	18 %tile	64 %tile	
	with significant gains measured	Non Verbal IQ WAIS-III	8 %tile	Average	
	in: Cognitive efficiency Working memory	12 year old Girl - 2 years in Arrow	wsmith Program		
	Visual motor integration Visual perceptual functioning,	Test	Pre-Arrowsmith	After 2 Years in Arrowsmith	
	Auditory processing for speech sounds.	Visual-Spatial Awareness	11 %tile	Average	
	Semantic knowledge Achievement skills (see additional test data in Chart on page 10)	Working Memory WISC-III (before) WISC IV (after)	4 %tile	Average	
		Processing Speed WISC-III (before) WISC IV (after)	38 %tile	90 %tile	
		8 year old Boy- 3 years in Arrowsmith Program			
		Test	Pre-Arrowsmith	After 3 Years in Arrowsmith	
		Working Memory For Numbers	2 %tile	43 %tile	
		Visual-Motor Copying Speed	5 %tile	50 %tile	
		Visual-Motor Integration BEERY	10 %tile	55 %tile	
		Processing Speed WISC-IV	12 %tile	45 %tile	
		Phonemic Awareness WJ-III	1 %tile	28 %tile	
		Sound Blending WJ-III	1 %tile	32 %tile	
		Auditory Processing WJ-R	1 %tile	32 %tile	
		Fluid Reasoning WJ-R (before) Concept Formation WJ-III (after)	4 %tile	25 %tile	
		Verbal Comprehension IQ WISC-III	4 %tile	26 %tile	
		Non-Verbal Intelligence TONI-3	32 %tile	58 %tile	
		Academic Fluency (Reading, Writing, Math Calculation Speed) WJ-III	Below grade level expectation	At grade level expectation	
		Math Calculation Skills WJ-III	1 %tile	62 %tile	

This report can be downloaded as a pdf document at: http://www.arrowsmithschool.org/arrowsmithprogram-background/research.html



## Relationship Between Arrowsmith Program Cognitive Exercises and Academic Skills

The following are some examples of the relationship between the cognitive programs and outcomes seen in specific academic skills and abilities.

READING			
Arrowsmith Program Exercise	Benefits		
Broca's Speech Pronunciation	Sound-symbol correspondence; sounding out words using phonics; smoother reading; better pronunciation		
Symbol Recognition	Sight word recognition; visual memory of words		
Lexical Memory	Remembering words; vocabulary building		
Symbol Relations	Understanding what was read; making connections between ideas in reading; inferential reasoning		
Memory for Information	Remembering information		
Symbolic Thinking	Getting the main point of what was read; thinking about the information and drawing conclusions; prioritizing information as to importance; appropriately interpreting text; thematic analysis		
Motor Symbol Sequencing	Reading speed; eye tracking for smooth reading; not skipping words, endings of words, lines in text; not losing place in reading		

WRITING			
Arrowsmith Program Exercise	Benefits		
Motor Symbol Sequencing	Automatic flow of ideas into writing; more ideas transferred into written format; smoother mechanical operations in writing; copying text more accurately and with greater speed; able to complete tests and assignments in less time; handwriting becomes more legible; uniform formation of letters		
Symbolic Thinking	Formulation of arguments in writing; relevant information is tied to thesis or main idea; less ambiguity in writing; less rambling, more to the point		
Symbol Relations	Logical train of thought; develops logical argument supported by details; demonstrates understanding of concepts being discussed; proper use of grammar		
Predicative Speech	Elaboration in sentences; proper use of grammar and placement of words in sequential order; good turn of phrase		

#### SPELLING

Arrowsmith Program Exercise	Benefits
Broca's Speech Pronunciation	Memory of sound-symbol correspondence for phonetic spelling
Symbol Recognition	Visual memory of words
Motor Symbol Sequencing	Muscle memory for writing words

#### MATHEMATICS **Arrowsmith Program Exercise Benefits Quantification Sense** Can perform Math calculations in head; quantification; sense of number; can learn and retain math facts Symbol Relations Understanding concepts; understanding the "why" in Math; sees relationships in concepts; processing information Memory for Information Remembering instructions and information in Math lessons and oral communication Symbol Recognition Visual memory for formulas Symbolic Thinking Able to determine what is relevant information in a Math word problem necessary to solve the problem; able to generalize formulae appropriately to solve problems Remembering order of operations; sense of procedure and steps in a Math **Predicative Speech** procedure Motor Symbol Sequencing Eye tracking for computations on paper; neat and legible work; less careless errors in written computation

# The Typical Arrowsmith Student

#### The typical student for the Arrowsmith Program:

- is of average or above average intelligence
- has a combination of the learning difficulties that are described in the Descriptions of Learning Dysfunctions on the Arrowsmith Program web site
- does not have severe intellectual, cognitive, emotional or behavioral disorders that would significantly affect his or her ability to participate in the Arrowsmith Program
- · does not have acquired brain injury or an autism spectrum disorder
- is 6 years of age or older

These are guidelines only. There are many students who fall within these guidelines, others who may require further consideration and still others for whom we feel this program cannot provide meaningful benefit.

Students entering the Arrowsmith Program have ordinarily been experiencing a range of problems including:

- reading
- writing
- mathematics
- comprehension
- logical reasoning
- visual memory
- auditory memory
- dyslexia
- non-verbal learning
- auditory processing
- attention

For more information on the typical Arrowsmith Program student, please review the information on our website under the tab, Suitable Students:

http://www.arrowsmithschool.org/arrowsmithprogram-background/suitable-students.html

To learn more about the Arrowsmith Program please visit our website at: <u>http://www.arrowsmithschool.org/</u>



# Arrowsmith Program Research Summary Document 2015



Strengthening Learning Capacities®

Arrowsmith Program 245 St. Clair Avenue West Toronto, Ontario M4V 1R3

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### ARROWSMITH PROGRAM RESEARCH SUMMARY DOCUMENT 2015

This Research Summary Document provides an overview of both completed and ongoing research conducted on the Arrowsmith Program. The studies have been divided into categories:



Related to this study:

<u>Listen to Dr. Boyd talk about the research</u> Listen to Howard Eaton, Director of Research, Arrowsmith Program. Director, Eaton Educational Group talk about the research



Related to these studies:

Resting State MRI Measures of Brain Function in Children

Listen to Dr. Rose talk about the research

Listen to Dr. Collins, Director, Brehm Institute for Cognitive Curricular Research, talk about the research



Research Study	Year	Study Description	Subjects/ Study Groups	Researcher(s)	University/ Affiliation
	Con	npleted Peer-Reviewed and Inde	pendent Resea	rch	
A Case Study of The Learning Disabilities Association Of Saskatchewan (LDAS) Arrowsmith Program	November 2013	Case Study research was conducted to investigate how participation in the Learning Disabilities Association of Saskatchewan (LDAS) Arrowsmith Program affected the cognitive, academic, emotional, and interpersonal functioning of five students who attended this program for two to three years.	5 students	Debra Kemp-Koo PhD Candidate	University of Saskatchewan Saskatoon, SK
Effects of the Arrowsmith Program on Academic Performance: <u>A Pilot Study</u>	June 2014	Pre- and post-intervention WJ-III achievement data was collected on 15 students in the Arrowsmith Program. NPStat non-parametric randomization tests were used to determine single-subject improvements across all academic variables, and paired sample t-tests were used to determine differences between pre- and post-testing for several academic domains.	15 students 11 males; 4 females; M age = 9.3 yrs SD = 1.36	James Hale, PhD, Hanna A. Kubas, MSc. Jessica A. Carmichael Kim R. Fitzer	Brain Gain Lab University of Calgary Calgary, AB
A Brain-Based Intervention Program That Changes Cognition: Implications for Academic Achievement	August 2014	Pre- and post-intervention cognitive data was collected on 15 students enrolled in the Arrowsmith Program. NPStat nonparametric randomization tests used to determine single-subject improvements across several cognitive domains. Paired samples t-tests used to determine improvements in short- term memory (Gsm), auditory processing (Ga), fluid reasoning (Gf), and processing speed (Gs).	15 students 11 males; 4 females; M age = 9.3 yrs SD = 1.36	James Hale, PhD, Hanna A. Kubas, MSc. Jessica A. Carmichael Kim R. Fitzer Howard Eaton	Brain Gain Lab University of Calgary Calgary, AB

### ARROWSMITH PROGRAM RESEARCH SUMMARY DOCUMENT 2015

Research Study	Year	Study Description	Subjects/ Study Groups	Researcher(s)	University/ Affiliation		
Completed Independent Research							
Evaluation of the Implementation of the Arrowsmith Program in the TCDSB	July 2000	A three month study comparing 15 students in the Arrowsmith Program within the Toronto Catholic District School Board (TCDSB) to a group of TCDSB students using Autoskill's Academy of Reading Program.	15 Arrowsmith Program students 12 comparison students from Autoskills Academy of Reading program	Data analysis completed by: Dr. Gordon McClure of the Community Health Systems Resource Group (CHSRG) of The Hospital for Sick Children			
Report on the TCDSB Study of the Arrowsmith Program for Learning Disabilities	January 2003	A one-year study comparing outcome measures of 30 grade 2 to grade 7 students enrolled in the Arrowsmith Program from 4 schools in the Toronto Catholic District School Board (TCDSB) to 10 students in a traditional special education classroom for students with learning disabilities.	30 Arrowsmith Program students 10 comparison students from grades 2 to 7	Dr. William Lancee, PhD Head of Research in the Department of Psychiatry at Mount Sinai Hospital and Associate Professor, Department of Psychiatry, University of Toronto			
Report on an Outcome Evaluation of the Arrowsmith Program for Treating Learning Disabled Students	November 2005	A three year outcome study of 79 children with learning difficulties conducted at Arrowsmith School funded by the Canadian Donner Foundation. A number of standardized measures were used such as achievement tests and tests of mental ability as well as measures of learning capacity and changes in rates of learning.	79 students from Arrowsmith School Toronto 53 males 26 females	Dr. William Lancee, PhD Head of Research in the Department of Psychiatry at Mount Sinai Hospital and Associate Professor, Department of Psychiatry, University of Toronto			

Research Study	Year	Study Description	Subjects/ Study Groups	Researcher(s)	University/ Affiliation		
Other Completed Studies							
Results from first year of St. Patrick Catholic Secondary School and Arrowsmith Program Pilot Project	June 1998	A pilot project undertaken in co-operation with St. Patrick Catholic Secondary School in the Toronto Catholic District School Board. Report summarizes the averaged quantitative improvements seen in 19 students working on four cognitive areas over a 7 month period.	17 students in grade 9		Toronto Catholic District School Board Toronto, ON		
<u>Changes Observed on</u> <u>Cognitive Scores of</u> <u>Arrowsmith Program</u> <u>Students</u>	1999-2007	Changes on Standardized Cognitive Measures of students in the Arrowsmith Program at Eaton Arrowsmith School or by Eaton Learning Centre	7 students	Howard Eaton	Eaton Learning Centre and Eaton Arrowsmith School Vancouver, BC		
Report on the Arrowsmith Program in the Toronto Catholic District School Board (TCDSB)	January 2007	A follow-up study tracking progress of students in the Arrowsmith Program in the TCDSB on standardized achievement measures, and the amount of resource support needed pre and post Arrowsmith Program.	120 students with learning difficulties in the Arrowsmith Program in the Toronto Catholic District School Board				

### **Other Relevant Documents**

The following list of documents and media provide further information on both completed and current research initiatives:

Research Section on the Arrowsmith Program website

Academic Skills and Learning Outcomes Brochure

**Research Initiatives Report** 

### Annexure R



# Average Student Growth ACER – MATHS PLUS



St. Peters – East Bentleigh (Melbourne)



# Average Student Growth ACER – PAT R (Reading Comprehension)



St. Peters – East Bentleigh (Melbourne)



Arrowsmith PROGRAM<sup>®</sup> Whole Cohort Year One Results

Pre-test: February 2016 Post-test: December 2016

## Comparison of results across four Year One classes (18 to 22 students/class)

- 3 classes used traditional handwriting programs
- 1 class spent 30 minutes each day doing the Arrowsmith Program cognitive exercise for learning motor plans necessary for writing

## **Assessment Tool**

Wold Sentence Copy Test - a standardized visual motor test used as a predictor of academic performance.

Student Results	Arrowsmith Class		Gifted Class		Academic Class 1		Academic Class 2	
Average Growth (letters per minute)	21		17		13		9	
	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test
No. students at or above grade level								
	2	19	6	14	7	9	1	9
Change:		+17		+8		+2		+8

### Annexure S

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	Home Parents & Students ~ Professionals & Educators ~ Media ~ Research ~ Neuroplasticity Can I be trained as an Arrowsmith Program teacher?	Barbara Arrowsmith Young
	Where can I/my child be assessed?	
	Which educational organizations will be offering the Arrowsmith Program in the future?	
	Is the Arrowsmith <b>Prog</b> ram available during the summer holiday period?	
	How many years do students spend in the Arrowsmith Program? The majority of students will require a three to four year program of full time attendance before returning to a full academic program in a public or private school or educational organization at his or her appropriate grade level. If a student is unable to complete the three to four year program, they achieve benefit each year they are in the program. Upon completion of the program some students may require one to two years to gain experience using their newly strengthened cognitive capacities and some students may need tutoring initially to bring academic skills to grade level.	
	Is the Arrowsmith Program available in other languages?	
	Where is the Arrowsmith School located?	
	Is there a part time program available for the Arrowsmith	