Research Report:
Arrowsmith Symbol Relations Cognitive Program Outcomes
Teen Challenge QLD Addiction Treatment Program

August 2024

ARROWSMITH

Overview

In August 2020 a project was started in collaboration with Teen Challenge, Queensland (QLD), Empowering Lives, and the Arrowsmith Program. The hypothesis was that the Arrowsmith Symbol Relations cognitive program would be of benefit to the group of individuals at Teen Challenge as they engaged in a treatment program for recovery from addiction.

The goal of the project was to trial the Arrowsmith Symbol Relations cognitive program in the Teen Challenge Queensland Drug and Alcohol Rehabilitation Centres to determine the impact on both cognition and how strengthening neural pathways that may have been damaged due to addiction could significantly impact the client's recovery and everyday life.

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, and those without learning challenges wishing to enhance performance. This is the first research project on adults overcoming addiction.

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

Research Method

2020/2021 Group

In 2020/2021, the study data was collected over 8 months on two measures:

- achievement measures on the Woodcock-Johnson IV Tests of Achievement
- a survey questionnaire of observed changes across a range of dimensions related to the Symbol Relations cognitive function

There were 8 participants ranging in age from 30 to 42 with a Mean age of 36.4.

2022/2024 Group

For the 2022/2024 study, data was collected over 5 months on three measures:

- cognitive abilities on the Woodcock-Johnson IV Tests of Cognitive Abilities
- a survey questionnaire of observed changes across a range of dimensions in relation to the Symbol Relations cognitive function
- a measure of the degree of severity on the Symbol Relations cognitive function

There were 20 participants ranging in age from 19.5 to 44 with a Mean age of 30.5.

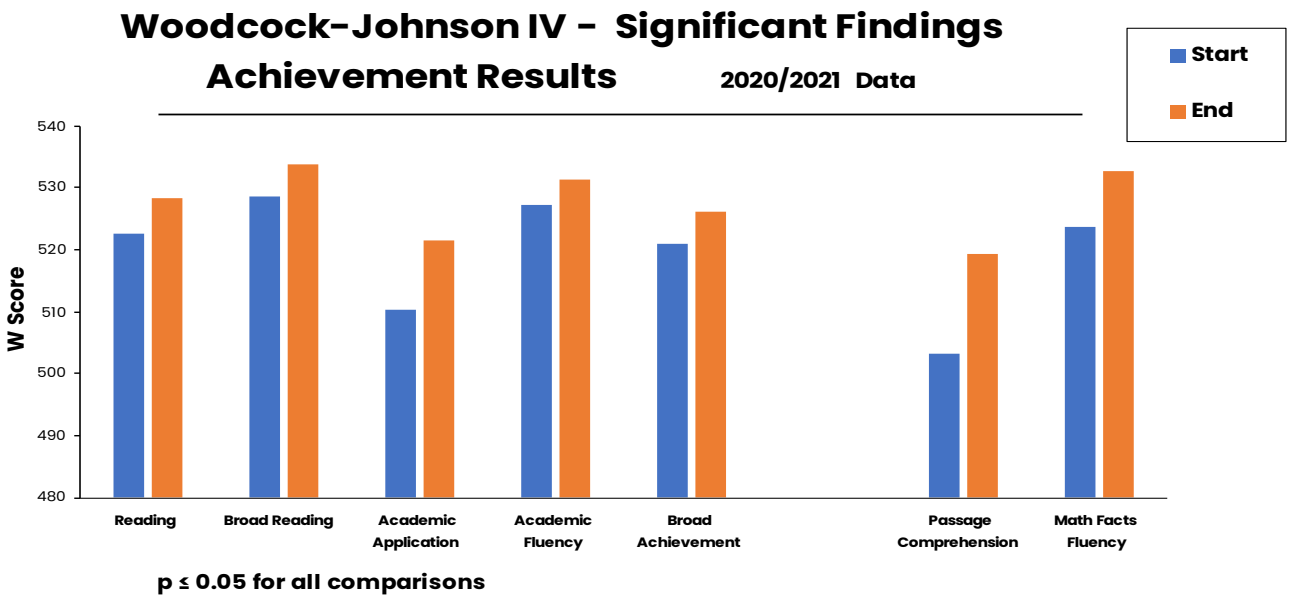
For information on the research measures used, See Appendix A: Research Measures Used.

2020/2021 Results

Woodcock-Johnson IV Tests of Achievement

The Woodcock-Johnson IV Tests of Achievement is an individually administered, norm-referenced instrument that measures specific areas of academic achievement in persons aged 4 to 90.

Significant improvements were measured on several areas of the Woodcock-Johnson IV Tests of Achievement.



The academic achievement areas showing significant Improvement:

Reading - word identification, reading speed, comprehension

Broad Reading – a composite of letter-word identification, reading fluency and passage comprehension

Academic Applications – a composite of passage comprehension, applied problems and writing samples

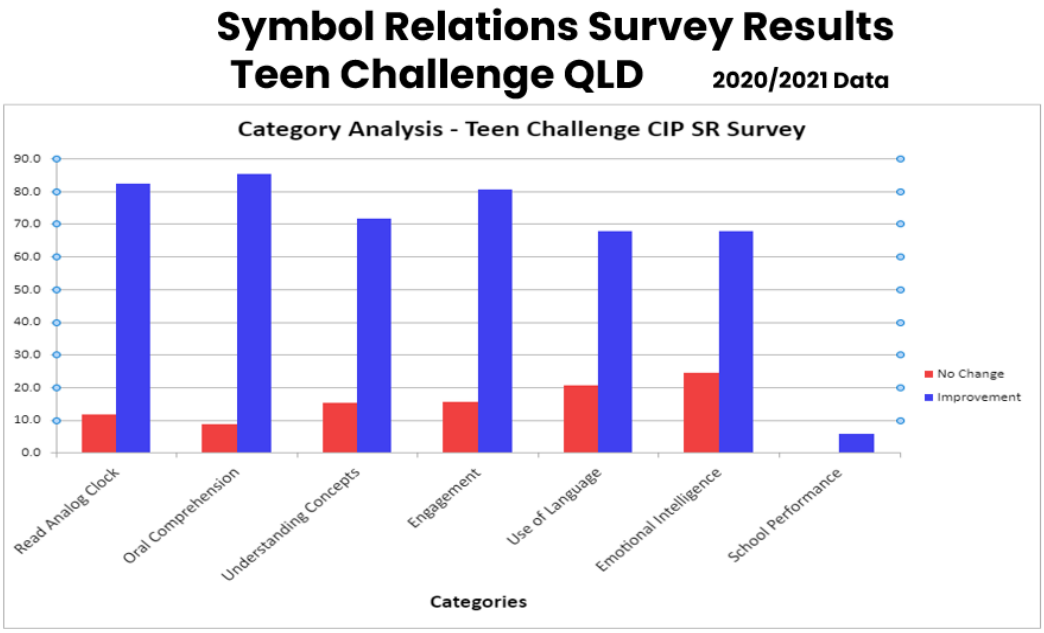
Academic Fluency – speed and accuracy in reading, doing simple math calculations and writing sentences

Broad Achievement – a composite of word identification, word attack, applied math problems, calculation, comprehension, writing samples, spelling, sentence reading fluency, math facts fluency, sentence writing fluency

Passage Comprehension – reading comprehension

Math Facts Fluency – speed and accuracy in simple math computations

Self-Report Survey Questionnaire



Significant improvements were reported on a number of domains:

Oral Comprehension – able to grasp more quickly and accurately what is heard

Understanding Concepts – enhanced logical reasoning, understanding rules, seeing the big picture

Engagement – greater focus, attention, and mental initiative

Use of Language – improved vocabulary and communication skills

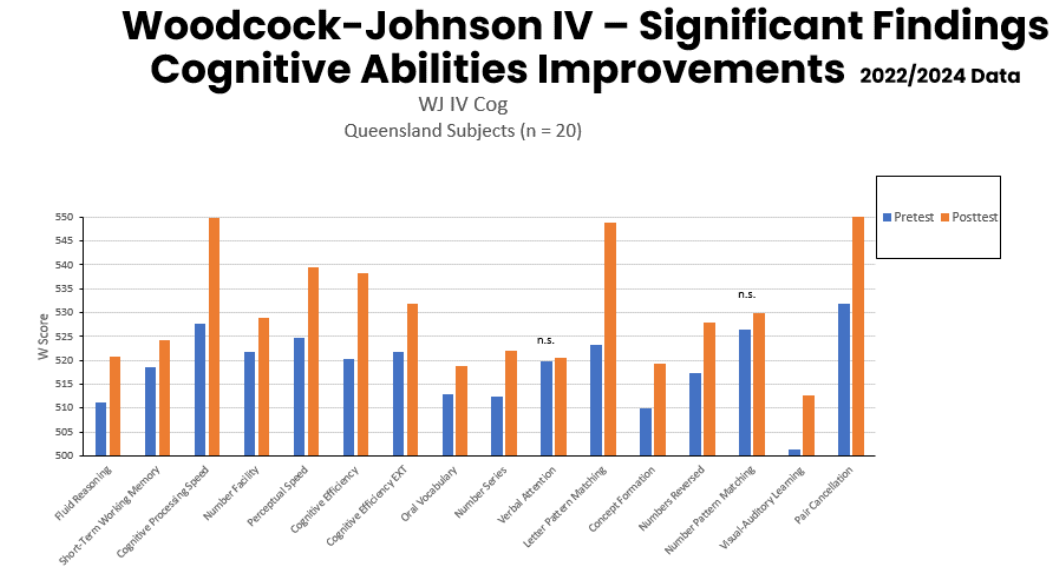
Emotional Intelligence – more able to interpret and express emotions, to reflect on behavior and problem solve in social situations, to understand interpersonal relationships, and more willing to engage in social situations.

2022/2024 Results

Woodcock-Johnson IV Tests of Cognitive Abilities

The Woodcock-Johnson IV Tests of Cognitive Abilities is an individually administered, norm-referenced instrument that measures specific cognitive abilities in persons aged 2 to 90.

The graph below shows statistically significant gains were made in many of the cognitive abilities on this standardised measure after 5 months of the participants engaging in the Arrowsmith Symbol Relations cognitive program.



All Tests Significantly Improved After SR Training except Verbal Attention & Number Pattern Matching
p Values range from 0.039 to < 0.0001

The cognitive areas showing significant Improvement:

Fluid Reasoning – measures broad ability to reason, form concepts, and solve problems using unfamiliar information or novel procedures.

Short-Term Working Memory – measures the ability to manipulate information in short-term memory to solve problems.

Cognitive Processing Speed – measures the ability to quickly perform both simple and complex cognitive tasks, particularly when under pressure to sustain controlled attention and concentration.

Number Facility – measures speed and accuracy working with numbers.

Perceptual Speed – measures the ability to rapidly identify matching items.

Cognitive Efficiency – measures the ability to cognitively process information automatically which frees up working memory.

Oral Vocabulary – measures vocabulary knowledge through assessing synonyms and antonyms.

Number Series - measures quantitative reasoning and inductive reasoning.

Letter-Pattern Matching– measures the speed at which one can make visual symbol discriminations and identify common orthographic (spelling) patterns.

Concept Formation – measures categorical reasoning based on principles of inductive logic.

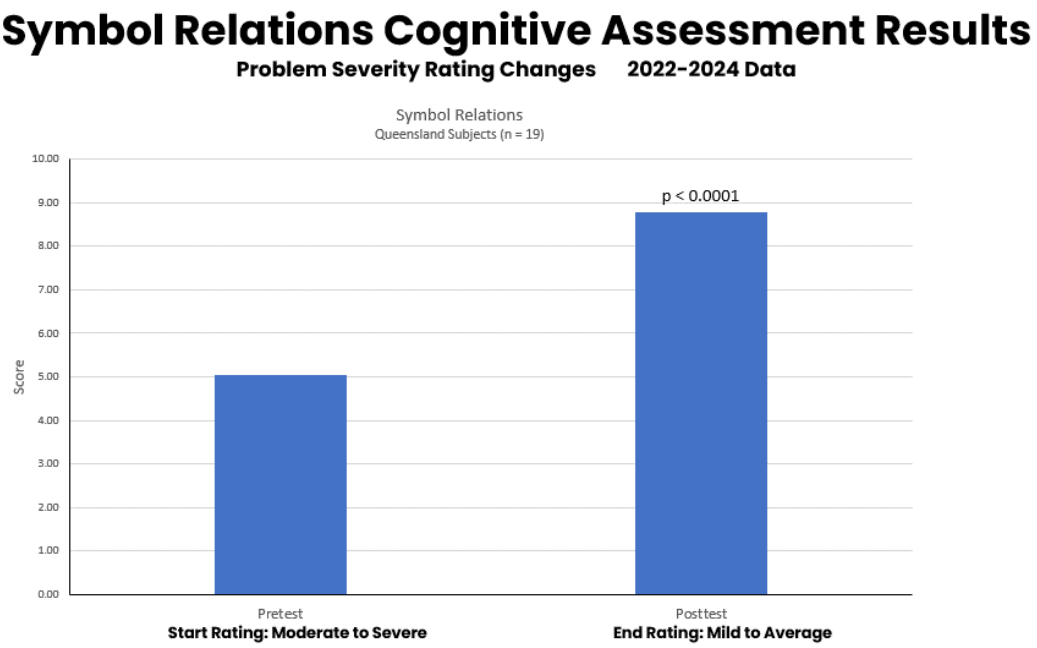
Numbers Reversed – measures short-term auditory working memory.

Visual Auditory Learning – measures long-term storage and retrieval.

Pair Cancellation - measures interference and inhibition control (executive processing) and sustained attention (attention/ concentration).

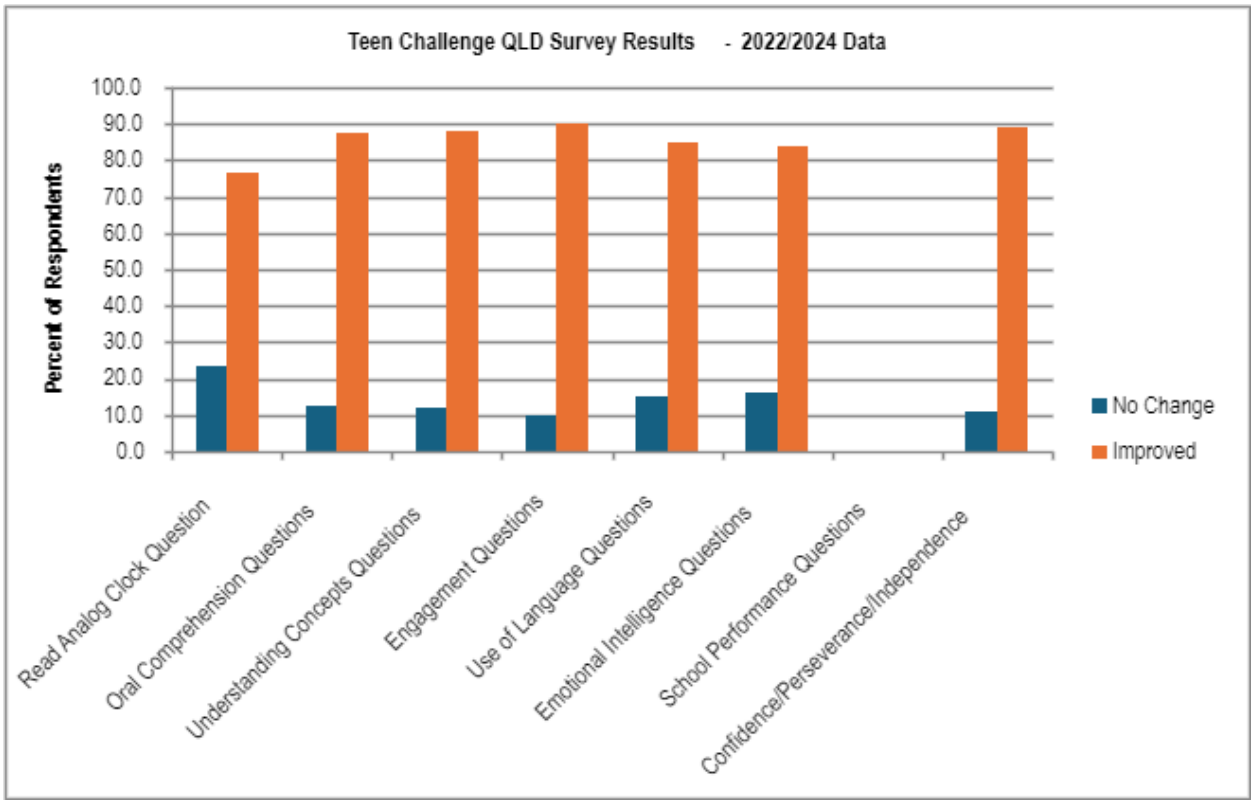
Symbol Relations Cognitive Function Assessment Results

Problem severity was evaluated on a test of the Symbol Relations cognitive function. A 12-point scale is used that covers the range from a Very Severe problem to Above Average functioning. Over 5 months of working on the Symbol Relations cognitive program, participants moved from an initial rating of a Moderate to Severe level of a problem to a Mild to Average rating. This was a statistically significant improvement.



2022/2024 Combined Data Self-Report Survey Questionnaire Results

Three to six months after completion of the Symbol Relations cognitive program, participants completed a questionnaire. Significant improvement was reported in several behaviours which correspond to the results noted above in changes in cognitive abilities. On analysis, these behaviours were grouped into the following categories, each of which showed significant improvement.



Oral Comprehension – able to grasp more quickly and accurately what is heard

Understanding Concepts – enhanced logical reasoning, understanding rules, seeing the big picture

Engagement – greater focus, attention, and mental initiative

Use of Language – improved vocabulary and communication skills

Emotional Intelligence – more able to interpret and express emotions, to reflect on behavior and problem solve in social situations, to understand interpersonal relationships, and more willing to engage in social situations

Confidence/Independence – more self-assured in situations, demonstrating greater perseverance, increased willingness to try new things and engage in challenging situations, more able to work independently, more self-confident.

Participants reported:

- greater self-awareness
- ability to think more clearly
- ability to focus for much longer and ignore distractions
- an ability to re-evaluate experiences and make connections as to why things happened
- an ability to perceive past events with more clarity
- a greater capacity to benefit from therapy
- increased empathy and emotional intelligence
- a greater sense of well-being
- increased locus of control through seeing themselves as agents of change in their lives
- improved decision making
- more able to communicate thoughts and feelings
- ability to reason more logically
- increased ability to remember events and details

Comparison of Results to Previous Research on Symbol Relations Outcomes

The significant changes measured in 2020/2021 and 2022/2024 on the measures of the Symbol Relations cognitive function, the Woodcock-Johnson IV Cognitive Abilities and Academic Achievement measures, and the self-report survey questionnaire all are consistent with other research conducted on this cognitive program and students with learning difficulties. See Arrowsmith Research

Previous Imaging Research

Previous imaging research has shown significant and positive changes in key neural networks as individuals work on the Symbol Relations cognitive program. These networks are: Default Mode Network; Executive Control (Frontal-Parietal) Network; and Salience Network. Strengthened connectivity within and between these networks improves a range of cognitive functions as the research is demonstrating significant improvements on the cognitive measures and the self-report measure. The cognitive functions related to these neural networks, described below, are essential in the therapeutic process as they are essential for insight, comprehension, understanding of self, others, and the social world.

The **Default Mode Network** is active when one is engaged in introspective activities such as:

- thinking about oneself
- thinking about the perspective of others
- contemplating the past or planning for the future
- daydreaming/big picture thinking/creativity

It is a critical network for Understanding of Self, including:

- autobiographical information such as memories of events and facts about oneself
- self-reference which refers to traits and descriptions we build of ourselves
- reflecting about one's own emotional state

It is active when thinking about others, including:

- when we think about the thoughts of others
- when we try to understand the emotions of others
- in empathy and moral reasoning
- when we evaluate social situations

Lastly, the Default Mode Network is active in remembering the past and thinking about the future, as well as episodic memory and story comprehension essential for understanding the narrative of our lives.

The **Executive Control Network** is active in directing and regulating goal-oriented behaviour necessary for planning, decision making, strategizing, monitoring our actions, and successfully executing goals.

It is involved in:

- attentional or cognitive control necessary for regulating one's attention and actions based on the demands of a situation and one's goals
- inhibitory self-control involved in resisting temptations and resisting acting impulsively
- working memory (holding and manipulating information in the mind as required to problem solve)
- cognitive flexibility (seeing possibilities and being able to adapt quickly and flexibly to changed circumstances)

The **Salience Network** is involved in emotional information processing. It plays a critical role in the process of understanding and identifying one's emotional states by allowing us to make connections between our physiological states and the emotions that give rise to them.

It is critical in emotional self-awareness through the integration of sensory, emotional, and cognitive information.

This network plays an important role in switching between the Default Mode Network with its focus on attending to internal stimuli and internally directed cognition to the Executive Control Network associated with processing external stimuli and externally directed cognition.

The Salience Network assesses the significance of external stimuli – it asks - what is critical, what is relevant, what should I pay attention to in my world? It is thought to be a bottom-up processor of salient experiences that then recruits other networks to influence behaviour. An example – the Salience Network receives emotional information from the limbic system that require an adaptive response and at that point, the Salience Network disengages the Default Mode Network and engages the Executive Control Network to take action in the external world.

So as the within and between network connectivity strengthens in these three neural networks, the individual's cognitive ability to understand their internal and external world and to take appropriate action improves.

Participants Report

"The most important way that the program has benefited me is that I know that my mind's potential has been redeemed and that my mind has been totally restored, perhaps even better than it used to be in past years."

"The Arrowsmith Program has helped my alertness, overall comprehension and logic of everyday things/activities. Also, improvement in social interactions and conversations/attention."

"It has helped me to understand things better and to have a new look at my life for the future."

"I can retain information when I read, my attention span has grown incredibly, and I can communicate better. I can connect my thoughts to my words now which has been a struggle for me for a while."

"I have felt a dramatic change in my decision making, with my artwork and in my ability to focus."

"I've noticed I have an improved ability to speak clearly and also an improvement in my anxiety levels. I have really seen an improvement in my ability to think clearly, recall information and match things up for written assessments."

"I have noticed I understand things more logically now when I am doing something. I am also improving a lot in other areas such as emotional and general intelligence."

Conclusion

The Symbol Relations cognitive program has shown to be a very effective adjunct to a treatment program for individuals recovering from addiction. Both the quantitative and qualitative data have shown it improves key cognitive functions which provide benefits in the treatment process.

Addressing cognitive areas that may have been impacted by addiction, helps improve cognitive and academic outcomes as well as assist the individual to gain insight, to regulate and understand emotions of self and others, to attach meaning to their emotional experience, to take the perspective of others necessary for empathy, to learn from past experiences and to apply these learnings to current situations. It helps in better therapy outcomes as well as preparing for re-entering society and the workforce after the participants have completed their program.

Research Organizations

The **Arrowsmith Program** is an organization that has developed a suite of cognitive programs that harnesses the principles of neuroplasticity through the application of targeted cognitive exercises to overcome specific cognitive difficulties. The Symbol Relations exercise, administered in this study, assists in laying a foundation so that the individual can understand, absorb, retain, and process information and make cause/effect connections necessary for insight. Some outcome examples include improved reasoning, comprehension, insight, thinking, planning, cognitive flexibility, and ability to regulate emotions. 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.

Teen Challenge QLD is a not-for-profit organisation, established in 1971 to provide long-term residential treatment and rehabilitation services for men aged 18-45 and women aged 18-39 who are struggling to overcome addiction and other life-controlling issues such as self-harm, eating disorders, depression, and homelessness. Substance abuse is one of the most prevalent issues facing our society. The impact of substance abuse in communities is both significant and complex, causing an increase in homelessness, criminal activity, mental health issues and family breakdown. Addiction is closely intertwined with cognition, with multiple factors such as drug effects, withdrawal effects and probability of relapse - linked with cognitive capacity.

Empowering Lives is an online Centre that runs the Arrowsmith Program for children and adults who may be facing learning challenges, or those wanting to enhance their cognitive capacity as they age. They also fund the Symbol Relations Program in the Teen Challenge Qld Centres and have funded this research project for the past 2 years.

Data Analysis

The data analysis was done by Dr. Greg Rose, Professor Emeritus, Southern Illinois University.

Appendix A: Research Measures Used

Survey Questionnaire

A questionnaire is completed by parents using a five-point rating scale to report on behaviours related to the Symbol Relation cognitive function. These behaviours are grouped into the following categories: oral comprehension; understanding concepts; engagement; emotional intelligence; and school performance.

Symbol Relations Cognitive Function Measure

A test using a 12-point scale is used to assess the level of proficiency in functioning on the Symbol Relations cognitive function from a very severe level of difficulty to above average functioning.

Woodcock-Johnson IV Tests of Cognitive Abilities and Achievement