

NEUROPLASTICITY AND NEUROSCIENCE IN EDUCATION

Ricoh Fellowship 2016/7 Eden Chapman

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WHAT IS NEUROPLASTICITY?

We all know that children learn a great deal in the first few years of life and it's long been widely accepted that children's brains grow and develop in some way. Neuroplasticity is scientific fact that explains this process but it also shows that this ability to learn, change the brain and repair pathways within the brain remain active and plastic throughout our entire lives.

The process of neuroplasticity is reasonably well understood. Anytime that we try to learn any new skill we call on our brains to exercise the neuroplasticity process – that is making brain cell connections. The more we practice (including bad habits) the stronger the connection gets until the skill becomes automatic. When we think about it we all learn new skills all the time: adapting to a new phone, driving a new car, using a new programme, taking up a new sport like mountain biking or bowls, compensating for physical injury or limitations.

We can all learn and master new skills due to our brains being plastic.



NEUROPLASTICITY PROVIDES US WITH A BRAIN THAT CAN ADAPT NOT ONLY TO CHANGES INFLICTED BY DAMAGE, BUT ALLOWS ADAPTATION TO ANY AND ALL EXPERIENCES AND CHANGES WE MAY ENCOUNTER...

FROM THE TIME THE BRAIN BEGINS TO DEVELOP IN UTERO UNTIL THE DAY WE DIE, THE CONNECTIONS AMONG THE CELLS IN OUR BRAINS REORGANIZE IN RESPONSE TO OUR CHANGING NEEDS. THIS DYNAMIC PROCESS ALLOWS US TO LEARN FROM AND ADAPT TO DIFFERENT EXPERIENCES.

Dr. Celeste Campbell

Applying Neuroplasticity to Education = Neuroeducation

HOW IT DIFFERS FROM WHAT WE CURRENTLY DO

Here's where things get very confrontational.

Neuroplasticity is not to believe in or not believe in, it's fact and indisputable. Taking into account that our brains are plastic calls on us to rethink the way we teach struggling learners.

My instinct and actions as a nurturing teacher over my career has been to support learners by giving the children the best teaching I know how in areas they have difficulty with, including teaching them to compensate or work around any deficits. But the very idea of neuroplasticity defies this idea. These children can be helped to strengthen their brain to overcome deficits eventually erasing the deficit completely in most cases. Given the right set of skills to practice, with repetition and reward students can significantly improve.

Complicating matters even further though is that we need to diagnose what cognitive deficits are limiting progress and this is where teachers are not trained or qualified. And rightly so.

There are assessment processes but like many aspects of neuroscience and neuroeducation these have been monetised in many cases. Even if we are able to diagnose the specific deficit, we then need to find the right intervention to best address the deficit, train someone to deliver the intervention and find the money to do so.

HOW CAN WE APPLY IT IN NEW ZEALAND SCHOOLS?

Funding from outside

Currently there are many programmes that claim to make a difference to children's cognitive development. These are almost all expensive and have ongoing licencing fees. This places the programme out of reach of most state schools, whānau and NGOs. To access most of these programmes schools would need to seek outside funding in an ongoing way, perhaps through a trust system similar to what's been established for Roots of Empathy.

Better out of schools?

It's become apparent to me that although these programmes work well for a number of students showing difficulties that no one school in Rotorua would be likely to be able to justify the investment and commitment to a single programme. The best course of action might be to create a resource that schools can share that is centralised somehow.

SUMMARY OF FINDINGS

1. Opportunistic neuroscientists have seen the potential of harvesting the education dollar and have carefully monetised most of the programmes available to help students.
2. Many programmes that claim to have a wide body of evidence supporting their claims around results are in fact written from within the respective organisations.
3. This doesn't mean that the programmes are not effective. The evidence I have seen is that most of the programmes work in some way and some may in fact be transformational. The Auckland University technical report "Behavioural Interventions to Remediate Learning Disorders" compiled by George Dawson and Stephanie D'Souza concludes with the following suggestions;
 - Be sceptical
 - Seek alternative judgement from non-profit organisations about programmes
 - Seek expert opinions about programmes.
4. Many of the programmes are designed to help students who are of above average intelligence, but have some cognitive processing issues (e.g., Asperger's, Dyspraxia, Dyscalculia). There are fewer programmes out there designed to help students with global delay such as those with FASD exhibit.

RECOMMENDATIONS

- A. If schools are looking for an intervention that can make a huge difference to an individual student, who is of otherwise average or above intelligence but has some cognitive issues, then the Arrowsmith programme is worth investigating. Seven Oaks School in Christchurch is running the programme and charging \$9000 per student, significantly less than the average of \$23,000AUD Australian Schools I visited were charging. One teacher at an Australian School said that putting one of your children through Arrowsmith programme was... "a privilege for the privileged" and although it appears to make a huge difference it is just so hard to see how it could be funded in the majority of New Zealand schools.
- B. The Fast ForWord programme is more within reach, particularly for bigger schools and has similar reach as the Arrowsmith Programme, but with less dramatic results. This programme can be used in a school for a fee starting at around \$1500.00. No special equipment is required, just a device with internet access and a pair of headphones.
- C. Feuerstein's programme has a cost involved in training teachers and a small per student fee but this programme may well represent the best value for impact solution across a whole school population.

WHAT ARE THE OTHER OPTIONS

Throughout my research I kept being drawn back towards Positive Psychology and Positive Education. Well-being (especially resilience) and character strengths were themes that kept rising to the top when reflecting on my learning community and the above interventions.

Furthermore the movement around resourcing and supporting children and their whānau for their “First 1000 days” continues to appeal to me as the most effective and value for money way to help children. This obviously needs to be driven by government policy and as primary educators we have little influence on this particular area. I believe we should use the term “First 1000 days” often in our work so that we are having an influence in the phrase becoming part of the nation’s vernacular.

Arrowsmith Programme

BARBARA ARROWSMITH YOUNG

Barbara Arrowsmith Young (born 1951) is a Canadian educator, author, entrepreneur and lecturer. She is the founder of Arrowsmith School in Toronto and the controversial Arrowsmith Program which forms the basis of the school's teaching method. In 2012 she published *The Woman Who Changed Her Brain* which combines an autobiographical account of her own severe learning disabilities and the method she developed to overcome them with case studies of learning disabled children who she claims overcame similar problems by using her method.

(Extract from https://en.wikipedia.org/wiki/Barbara_Arrowsmith_Young)

FULLTIME PROGRAMME

The Arrowsmith Programme has been running since the late 1970s. It is firmly based on principles of neuroplasticity and rectifying cognitive deficits. Assessment carried out on students enrolling in the Arrowsmith Programme diagnose strengths and weaknesses in 19 cognitive areas leading to therapies in up to 8 cognitive exercises.

Students in the fulltime programme practice (usually) four cognitive exercises over four 40 minute sessions per day. These exercises are difficult and extremely repetitive. I witnessed students carry out these activities though and was impressed with the dedication and focus they gave to the tasks, but more so the amazing celebrations that occurred across the whole class when students reached a mastery of a certain level.

EXERCISE EXAMPLES (2 OF 8 EXERCISES)

Symbol relations - Clocks

This fascinating and bewildering exercise takes a reasonably recognisable object and turns it into a nightmare! "Clocks" takes students from learning to read our familiar two or three handed analogue clock and adds up to seven more hands measuring year, month, date, am & pm and 60ths of a second. Students use a computer programme where the clock arrives on screen then as quickly as possible the student enters in all the data each of the ten hands are referring to and hit the enter key. They get a tick or a cross and the next clock appears. The students aim is to do each clock as quickly as possible with 90% accuracy.

Motor Symbol Sequencing – tracing with eye patch

This more familiar activity see students wearing an eye patch over their right eye to ensure that the correct area of the brain is doing the practice. Students trace over the green shapes as accurately as they can before turning the sheet over to the teacher, who notes how often the student has made a marking outside of the green area of the shape. This determines whether or not the student has completed the task satisfactorily.

School visits – Melbourne Australia

I was welcomed by all three Victoria Schools that are running the Arrowsmith Programme. All three were very pleased with the programme and excited about the results they were seeing.

ST PETER'S PRIMARY SCHOOL

St Peter's has been running the Arrowsmith Programme for 2 years - the longest in Victoria. They cater for 20 students charging \$18,000 to be part of the programme. I observed in the classroom for an hour and watched students give remarkable focus to exercises that seem tedious and repetitive. I witnessed a student achieve mastery on one of her tasks, and this success was celebrated eagerly by all the children in the class, and most enthusiastically by the student herself.

St Peter's School had a document full of testimony from parents about the success of the programme and the transformational effect it had had on their children.

OAKLEIGH GRAMMAR SCHOOL

The Arrowsmith Programme started at Oakleigh Grammar in 2016. They started with 20 students, charging \$23,000 per student. In 2017 they are extending to 40 students and 12 adult students.

I visited the classroom and witnessed a student achieving mastery with much the same reaction as at St Peter's. The teachers were very excited about the programme and were happy to talk to me about their experiences with it.

I also attended their open night to speak to prospective students and families about the Arrowsmith Programme. The most interesting part of this evening was hearing from young adults whose families had taken them to Canada to attend the Arrowsmith School and their stories were all about how their lives had been transformed.

PLENTY VALLEY CHRISTIAN COLLEGE

Not much new information was gained from visiting this school as it was my third school visit and they didn't allow me to visit the classroom lest the students be disturbed.

PVCC Arrowsmith Programme caters for 20 students at \$22,000 per head.

School visits – Christchurch New Zealand

SEVEN OAKS (SMALL PRIVATE SCHOOL)

The Arrowsmith programme has been running here for three years and it was being delivered to six students at the school at the time, at around \$9000 per student.

The new principal was a fan of the programme, but she consistently compared the programme to Feuerstein and favoured it for its greater reach throughout the school and its compatibility with Positive Education / Psychology.

Is it effective?

The short answer is yes. The longer answer is that no one from outside the organisation can agree why. One item of research I read asserted that gains are only made due to the demanding nature of the programme and the huge amount of practice in concentrating. Another paper I read was more generous saying that the cognitive interventions appeared to change the brain, but was non-committal in saying how it was able to do so.

The most compelling testimony came from ex-students who reported life changing effects, having previously been seriously disadvantaged in their everyday lives. I saw some of these testimonies in person at Oakleigh Grammar School as well as in various videos found on the internet.

Programme Options

Until very recently the only option to engage with the Arrowsmith programme was a full assessment, followed by a programme addressing four cognitive deficits (at a time) for four 40 minute sessions per day over the course of 2-4 years. In very recent times the Arrowsmith Foundation has released quite a few more options. Some of these options may work in a New Zealand or Rotorua setting.

Part time On-Site Program

The On-Site Program can address up to three cognitive deficits per year. The student will engage in each cognitive program for four hours per week.

Cognitive Enhancement Models

The general population can benefit from improving fundamental cognitive functioning and the Arrowsmith Program offers opportunities to participate through its Cognitive Enhancement models. This model does not require assessment. There are two ways a site can implement such a model.

Whole Cohort Program

In a Whole Cohort Program, students in a mainstream academic class will participate in one 40-minute cognitive period each day. In this cognitive period, students will engage in one cognitive exercise that works to strengthen a particular cognitive function that would most benefit that age-group. Specialized Whole Cohort Program training and regular classroom support for the cohort teacher will be required for the implementation of this type of program.

Cognitive Enhancement Program

This model will provide cognitive enhancement to participants in the cognitive function of Symbol Relations. This cognitive function is involved in processing concepts across all academic disciplines, understanding and quickly grasping what is read and heard, gaining insight, logical reasoning, seeing connections between ideas, cause and effect processing, and mathematical reasoning. Students in this model would complete a minimum of four hours per week on this cognitive exercise across a ten month period. Specialized training for a teacher will be required for the implementation of this type of program.

Fast ForWord

*“Fast ForWord is a family of **educational software** products intended to enhance **cognitive** skills of children, especially focused on developing “phonological awareness”. It is marketed as a therapy for strengthening the skills of memory, attention, processing rate, and sequencing for children. It evolved from studies that showed children with abnormal temporal processing and language learning impairment could have their **phonological awareness** improved in parallel with their temporal processing. It is currently marketed for children with a broad range of reading problems, and perhaps other **cognitive disorders** as well.*

Independent scientific analysis of the Fast ForWord product has shown some support for the effectiveness of the product in treating children’s learning challenges.”

Adapted from https://en.wikipedia.org/wiki/Fast_ForWord

The structure of the programme is essentially a device based online adaptive learning programme. There is an initial assessment (Reading Progress Indicator) that gives an approximate grade level (based on USA grades). Following this assessment the students are assigned learning games to play, and again these are adaptive and progressive. There is a large variety of games that develop skills such as listening, phonemic awareness, sequencing and spatial awareness.

The games are moderately engaging through cute graphics but the gameplay is not especially exciting.

There is a huge amount of useful data that the programme generates about the students, including alerting staff if students are not trying their hardest, identifying problems areas (e.g. with particular sounds) and providing a large list of support learning materials to address difficulties.

School Visits – Bay of Plenty / Tauranga

OTUMOETAI COLLEGE (LEARNING SUPPORT CLASS)

I observed the programme in action in a learning support class at Otumoetai College. The class was described as “potentially flighty” and while I was watching the students using the programme 8/10 students were engaged all or nearly all of the time. Two students were less engaged, one consistently distracted by the tennis practice happening outside, and one clever student who had put his earbuds in under his headphones so that he could enjoy his own music!

The school has been using the programme for three years now and is beginning to develop some longitudinal data showing the programme has a positive and ongoing impact on learning for students that display some cognitive issues. The staff that are most involved with running the programme are hoping to share the software with other schools within their Community of Learning (CoL) so that the intervention can be used earlier as they feel it would be of even greater impact.

The staff were very enthusiastic about the programme and diligently delivered the programme every day for 30 minutes per day as part of their timetable. The school owned a site licence and the programme was costing around \$500 per students to implement.

Is it effective?

There is a large body of research showing that the programme is effective. Most peer-reviewed studies have been authored by Fast ForWord researchers. These report significant improvement in reading and writing, comprehension and oral language abilities as well as showing increased brain activity.

Eden Chapman 2017

Feuerstein

“The Instrumental Enrichment programme (IE) is a curriculum in thinking, which is designed to enhance cognitive functioning, and is based on Feuerstein’s theory of Structural Cognitive modifiability and a philosophy that all children, young people and adults can learn and change their level of functioning.

The goal of the IE programme is the development, refinement, and crystallisation of thinking processes that are needed for effective thinking, problem solving, and decision making. It focuses on transforming passive and dependent learners into more active self-motivated students.

For students who have previously experienced failure in school, IE creates opportunities to gain insights into their way of thinking, attitudes, and feelings. They can begin to appreciate that the source of their difficulties is not due to their inferiority, inability, or lack of intelligence, but is due to inefficient strategies or lack of thorough planning.”

Description from <https://www.nzfeuerstein.org/>

The research into this approach was not part of my study, and neither is it a programme as such. It came up time and time again in discussions with schools and in my reading and deserves to be highlighted in this report for this reason. There is ample research into the programme and this can be easily explored online.

Free Apps available on Google Play and the App Store

Free Apps

There are thousands of related apps that can be used on Windows, Android, Chrome and Apple systems. These will be of varying quality and usefulness, as well as requiring fees to unlock the best features. There was no way I could even begin to assess them all.

Speaking only from experience of using apps in general that the free ones are so limited that their usefulness is proportionately limited, and so only paid apps are probably worth using in a school setting.

A google search for “apps to develop cognitive” reveals over 700,000 results. One the first page there are various pages listing between 5 and 100 apps so there is absolutely no shortage.

The Huffington Post published an article in April 2014 that listed their favourite 10 apps to train your brain (http://www.huffingtonpost.com/2014/06/04/brain-exercises_n_5438222.htm);

1. Lumosity

This popular app is split into sessions of three games tailored to your goals: memory, attention, problem solving, processing speed or flexibility of thinking. The games are played against the clock and change every time. Developers say just one session a day can improve mental skills and users can track progress and compare performance with others. (Free for limited access, upgrade for \$15 a month or \$80 a year; available for iOS)

2. CogniFit Brain Fitness

Improve cognitive abilities, such as memory and concentration, with sleek, fun and addictive games designed by neuroscientists. Users can track progress and access insights about overall brain health. Competitive players can challenge friends, too. After an initial quiz, the app adapts each game's difficulty to your profile and gives you recommendations based on your results. Developers found that users saw improvement by spending at least 20 minutes, two to three times a week, playing the games. (Free for four games or full subscription for \$13 a month or \$120; available for iOS)

3. Personal Zen

Players follow two animated characters, one of which looks calm and friendly while the other looks angry, as they burrow through a field of rustling grass. This game, developed by Dr. Dennis and researchers from Hunter College and the City University of New York, reduces anxiety by training your brain to focus more on the positive and less on the negative. “The habit of thinking about the world in a more positive light — like looking for a silver lining in a bad situation — is one of the key ways we can promote our own resilience in the face of adversity,” says Dr. Dennis. Even a single session of play can build resilience over several hours. She suggests using the app right before a stressful event, but 10 minutes a day will help build more enduring positive effects. (Free; available for iOS)

4. Brain Trainer Special

Like Lumosity, this Android app contains games that have you memorizing letter sequences, phone numbers and solving assorted math problems to keep your mind in tip-top shape. Difficulty levels range from easy to brain-tingling hard. (Free; available on Google Play)

5. Brain Fitness Pro

Brain Fitness Pro employs a series of memory training exercises to increase focus, memory and problem-solving skills. Developers say that intensive working memory training dramatically increases attention and general cognitive skills and that these benefits remain long term. (\$4; available for iOS)

6. Happify

Train your brain to be happier? Yep, research shows that some activities help build your ability to conquer negative thoughts, show gratitude, cope with stress and empathize — all essential ingredients for a fuller, happier life. Using fundamentals of positive psychology, which involves focusing on the strengths and virtues that enable individuals to create fulfilling lives, the app’s quizzes, polls and gratitude journal — combined with a positive community — gradually teach life-changing habits. The goal is to build these skills and keep users smiling all day. (Free; available for iOS)

7. Positive Activity Jackpot

This app was originally developed for service members returning from combat with high risk for post-traumatic stress disorder. It uses augmented reality with an Android phone’s GPS to find nearby activities and diversions for someone coping with depression. If you cannot make up your mind what to do, “pull the lever” and let the app’s jackpot function make the choice for you. PAJ is based on a form of behavioral therapy called pleasant event scheduling, which encourages a daily schedule of enjoyable activities to improve moods and overcome despondent thoughts. (Free; available on Google Play)

8. Fit Brains Trainer

More than 360 unique games and puzzles aimed at stretching and improving your mental agility lead users through various tasks. Sessions get harder as you improve and will always challenge you and provide a solid brain workout. Keep track of your progress and performance tools and the program offers training recommendations for best results. (Free; available on iOS and on Google Play)

9. Eidetic

Eidetic uses a technique called spaced repetition to help you memorize anything from important phone numbers to interesting words or facts. It works differently from typical brain training apps by using items that have meaning and context, like your beau's phone number, bank account details or a new quote worth reciting. Notifications remind you when it's time to test yourself and spaces out tests over time to make sure you retain the information in long-term memory. (Free; available on iOS)

10. ReliefLink

Dr. Kaslow developed this award-winning app for suicide prevention but it can be used as a general mood tracker. "It's like MyFitnessPal in that you can track all sorts of things that are relevant to your mental health," says Dr. Kaslow. It also includes unique coping methods, such as voice-recorded mindfulness and relaxation exercises, or relaxing music. The map locator pinpoints nearby therapists, support groups and mental health treatment facilities, too, in case you ever need to talk to a professional.

References

1. Arrowsmith-Young, Barbara (2012). *the woman who changed her brain*. New York, NY: HarperCollins
2. Doidge, Norman (2010). *The Brain That Changes Itself : Stories of Personal Triumph from the Frontiers of Brain Science*. Carlton North, Vic. :Scribe Publications.
3. George Dawson and Stephanie D'Souza (2015). *Behavioural Interventions to Remediate Learning Disorders*., Auckland University
4. Education with neuroscience 2016 Dr Martha Burns presentation:
<https://www.youtube.com/watch?v=cRmEqNZvvcA>
5. Fixing My Brain: Neuroplasticity and the Arrowsmith Program:
http://fod.infobase.com/p_ViewPlaylist.aspx?AssignmentID=dkpkbj
6. Fetal alcohol spectrum disorder and learning: <http://inclusive.tki.org.nz/guides/FASD>
7. [Supportive Fluency Instruction: The Key to Reading Success \(Especially for Students Who Struggle\)](#): Timothy Rasinski.
[http://www.learnfastforschools.com.au/hubfs/Pdf/Supportive_Fluency_Instruction -
_A_white_paper_by_Scientific_Learning.pdf?t=1473232200737](http://www.learnfastforschools.com.au/hubfs/Pdf/Supportive_Fluency_Instruction_-_A_white_paper_by_Scientific_Learning.pdf?t=1473232200737)
8. [Neural deficits in children with dyslexia ameliorated by behavioural remediation](#): Temple et al.
[http://www.learnfastforschools.com.au/hubfs/Pdf/Neural_deficits_in_children_with_dyslexia_ameli
orated_by_behavioural_remediation_-_Temple-et_al.pdf?t=1473232200737](http://www.learnfastforschools.com.au/hubfs/Pdf/Neural_deficits_in_children_with_dyslexia_ameliorated_by_behavioural_remediation_-_Temple-et_al.pdf?t=1473232200737)
9. [Matching Learning Style to Instructional Method](#): Beth A. Rogowsky, Barbara M. Calhoun and Paula Tallal.
[http://www.learnfastforschools.com.au/hubfs/Pdf/Matching_Learning_Styles_to_Instructional_Met
hod_-_Effects_of_Comprehension_-_Rogowsky_Calhoun_Tallal_2014.pdf?t=1473232200737](http://www.learnfastforschools.com.au/hubfs/Pdf/Matching_Learning_Styles_to_Instructional_Method_-_Effects_of_Comprehension_-_Rogowsky_Calhoun_Tallal_2014.pdf?t=1473232200737)

10. [Technology Holds Promise for Students with Poor Vocabulary Skills: Dr Steve Miller.](http://www.learnfastforschools.com.au/hubfs/Pdf/Technology_Holds_Promise_for_Students_with_Poor_Vocabulary_-_Dr_Steve_Miller.pdf?t=1473232200737)
http://www.learnfastforschools.com.au/hubfs/Pdf/Technology_Holds_Promise_for_Students_with_Poor_Vocabulary_-_Dr_Steve_Miller.pdf?t=1473232200737
11. [Neuroplasticity-based cognitive and linguistic skills training improves reading and writing skills in college students: Rogowsky et al.](http://www.learnfastforschools.com.au/hubfs/Pdf/Neuroplasticity-based_cognitive_and_linguistic_skills_training_improves_reading_and_writing_skills_in_college_students.pdf?t=1473232200737)
http://www.learnfastforschools.com.au/hubfs/Pdf/Neuroplasticity-based_cognitive_and_linguistic_skills_training_improves_reading_and_writing_skills_-_Rogowsky_et_al_published_in_Frontiers.pdf?t=1473232200737
12. [The Myth of Multitasking: Christine Rosen.](http://www.learnfastforschools.com.au/hubfs/Pdf/The_Myth_of_Multitasking_-_Christine_Rosen.pdf?t=1473232200737)
http://www.learnfastforschools.com.au/hubfs/Pdf/The_Myth_of_Multitasking_-_Christine_Rosen.pdf?t=1473232200737
13. <http://www.brainline.org/content/2009/02/ask-expert-what-neuroplasticity.html>
14. <http://www.sandhillsneurologists.com/neuroplasticity/>
15. <https://www.cogaudits.org/audits> (Auckland University audits of several cognitive programmes)
16. https://media.wix.com/ugd/bcabcf_930c70ef7d2c47f8a449cdc0e79f5762.pdf
17. <http://www.brainwave.org.nz/>
18. http://www.nzcpm.org.nz/media/64578/2013_08_first_1000_days_policy_statement.pdf
19. <http://www.hauora.co.nz/assets/files/Children/1000-days-to-get-it-right-for-every-child.pdf>
20. http://www.huffingtonpost.com/2014/06/04/brain-exercises_n_5438222.html