PRACTICALLY MINDED

The Benefits and Mechanisms Associated with a Practical Skills-Based Curriculum

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While the outcomes of a practical skills therapeutic education have been valued and noted (LSC, 2008; Ofsted, 2007, 2010, 2014), research in cognitive neuroscience and psychology continues to find surprising and previously unrecognised benefits that are conferred upon pupils. Moreover, the mechanisms behind these benefits point to the urgent need for greater incorporation of such practical elements into *mainstream* education. Beyond the cognitive and neurological aspects of the practical skills-based curriculum are secondary processes such as mentoring through apprenticeship. These produce further benefits that aid the development of the pupil into a more socially viable and employable young adult. The findings of this report are applicable to pupils with or without learning difficulties.

EXECUTIVE SUMMARY OF FINDINGS

The following is an overview of the conclusions contained in this report.

- Practical and craft-based education develops a more general capacity to function and work in other areas: competencies are ‘transferable’ in a broad sense.

- A curriculum rich in manipulation of materials, creativity, experimentation and design is linked to positive employment outcomes for craft-based students.

- However, some of the mechanisms underlying these benefits are poorly understood by those working in education.

Three-Dimensional Skills

- A curriculum primarily based on practical skills activities cultivates precisely the cognitive and physical experiences necessary for full intellectual development.

- In particular, practical curricula develop visual and three-dimensional skills and an understanding of materials and processes. Researchers believe, “In the transition towards a digital future it is important that an experience of tangible 3D qualities is maintained …”

- Yet, increasing time spent in the virtual world of ICT screen technology is displacing hands-on play and hands-on learning that allows young people to experience how the world works in practice and to make informed judgments about abstract concepts. This change is producing the first signs of a ‘software-instead-of-screwdriver-society’.

- Studies of children with ASD are finding a more pronounced attraction to screen overuse. There are strong associations between ‘Internet

addiction' and 'autism-traits'. Moreover, children with ASD are more likely to have problems disengaging from computer games. Boys in particular 'are much more likely to develop problematic or addictive patterns of video game play.' Given the emphasis on 'real-world' 3-D learning, a practical skills therapeutic education is likely to minimize this risk.

There now appear to be neurological explanations as to why working with one's own hands in a 'real-world' 3-D learning environment is imperative for full cognitive and intellectual development.

Cognitive and Neurological Development

- Young autistic individuals seem to have a weak 'mirror neuron system' in their brain, which is thought to underlie greater social impairments. Neuroscientists believe that brain stimulation may be used to improve mirror neuron activity in autism spectrum disorder, which could have substantial potential therapeutic implications.

- Using tools such as those in craft activities, uses and strengthens mirror neuron systems. This extends far beyond the skills, hand-eye and muscle coordination related to the craft. Such tool use - described as *"complex, real-world behavior*" – also involves and stimulates "*social, cognitive, perceptual and motor processes*."

- The practical skills therapeutic education advanced by the RMET may, in effect, be providing a greater degree of stimulation to the brain's mirror neuron systems of young people. And this may underlie the conclusions of recent Ofsted inspection reports, '*They develop highly effective communication and personal skills which enable them to participate confidently as valuable members of the wider community.*'(Ofsted 2010) '*Students develop their social skills well. They greatly increase their ability to make confident choices,*

*communicate more effectively and begin to manage their own behaviour. (*Ofsted 2014)

- The learning brain receives high levels of vital information through the sensations and movements of the hands.

- Elements of hand use such as movement velocity, direction and mode of coordination in craft activities are reflected in ‘robust’ brain activity.

- This may partly explain why most human beings find learning easiest when they begin a learning experience with a ‘hands-on’ kinesthetic activity.

- New research suggests that different ways of using the hands may have profound effects on how individuals think.

- ‘Hands-on’ exploration seems critical for the development of understanding and inventiveness. The use of hands seems central to intelligence and crucial to full cognitive learning.

- There is concern regarding a shift in educational policies, which reduces the role of working with hands and removes woodwork, metalwork, music or car mechanics from the educational curriculum.

- Motor skill learning induces actual structural and functional changes in the brain.

- The neuro-cognitive effects of craft based activities have now been employed clinically to improve cognitive functioning.

‘Whole-Body’ Learning

- Physical Literacy - physical movement skills - is increasingly thought to be linked to academic and intellectual performance. Autistic children

with better motor skills have been found to be more adept at socializing and better at ‘daily living skills’.

- ‘Whole-body’ learning of a practical skills therapeutic education seamlessly keeps young people moving and physically active. Practical skills therapeutic education involves a great deal of general body movement and physical activity and low levels of sedentary time. And as is the case with hand movement and tool use, general body movement and physical activity has profound cognitive and intellectual implications for students.

- Physical activity appears to provide short-term reductions of stereotypic behaviours in young people with ASD. Furthermore, benefits are not limited to these stereotypical behaviours; several studies have found improvements in other areas for those with ASD.

- Physical fitness is now associated with a larger hippocampus in the brains of children. Higher IQ, intellectual performance and achievement are now linked to greater physical activity and fitness.

- And the physical activity taking place within the woodland ecology, gardening, horticulture and farming components of integrated practical skills therapeutic education may afford additional benefits. Recent research has found that even small doses of outdoor physical activity can have significant effects on mental health.

Locus of Control

- The mechanism by which practical skills-based activities - where the learner is fully involved in all stages of the process - produces positive effects, may be in part by reinforcing and cultivating a greater internal *locus of control* within the student which becomes generalised.

- Through crafts, students gain a greater sense of control over a wider range of things in their lives. For example greater internal locus of control is "*significantly related to educational attainment"* and is linked with having a lower level of work-family conflicts.

- Emotional stability, behaviour and mental health are also influenced by locus of control, along with an increased ability to delay gratification, tolerate ambiguous situations, or resist coercion, a lower association with suffering from anxiety, and a reduced risk of suffering from depression, other psychopathologies, and behavioural problems.

Attentional Functioning and Self-Regulation

- The process of 'start-to-finish learning' reinforced through a practical skills-based curriculum cultivates greater sustained attention, self-regulation and deferred gratification vital to impulse control.

- These self-regulation abilities - including the ability to alternately shift and focus attention and to inhibit impulsive responding - are uniquely related to early academic success and are now considered more important in early academic progress than measures of intelligence

Green Curriculum

Curricula involving woodland ecology, gardening, horticulture and farming are increasingly found to positively affect cognitive functioning, academic performance, obesity and physical and mental health in young people e.g.:

- Children with symptoms of Attention Deficit Hyperactivity Disorder (ADHD) are better able to concentrate after contact with nature. The same is true of people *without* ADHD.

- Children with contact with nature score higher on tests of concentration and self-discipline.

- Results for schools with outdoor education curricula show better performance on standardised measures of academic achievement in reading, writing, math, science and social studies. Classroom behavior shows improvements as well.

- Nature buffers the impact of life's stresses on young people and helps them deal with adversity. The greater the amount of nature exposure, the greater the benefits

- Regular exposure to nature and greenery increases self-discipline in students.

- Contact with nature is linked to an increase children's self-esteem.

- Greater generosity and compassion are now linked to being immersed in natural environments of the type found within the woodland ecology, gardening, horticulture and farming components of integrated practical skills therapeutic education.

Agricultural Literacy

- A curriculum involving contact with agriculture makes the abstract more concrete – pupils are more likely to absorb and integrate food knowledge if they have hands-on experience of its origins. The degree of contact pupils have with the agriculture translates into a better understanding and awareness of the food chain. Furthermore, pupils with greater agricultural literacy are more likely to make better food choices.

Storytelling

- Most young people today are exposed mainly to imposed imagery: television, DVDs, computer-based images, and even picture books. Brain activity is reduced by perceiving something that is already apparent, rather than creating an image of something that is not apparent. Storytelling, or reading aloud a chapter, is an effective method of stimulating the brain's ability for induced imagery - storytelling provides excellent cognitive exercise.

- The oral story holds the attention of the listener and this process of focusing a group's attention contributes to other educational activities, enhancing social skills and confidence.

Context of Curriculum

- The specific benefits of a practical curriculum above are potentiated by the environment and context in which learning takes place.

- Factors such as low pupil to teacher ratio, mentoring and apprenticeship, positive role modelling, gaining ‘a sense of the elder’ - are all highly significant. There is also great emphasis on seeing a process through from its source to an end result which provides a sense of **connection and continuity** which goes further than the college, linking with the traditions and environment of the community in which the college exists. Crafts also contribute to a moral and social development as they possess an inherent lawfulness.

“The new employability agenda for higher education …requires an holistic

approach” Higher Education Academy (2003)

The Integrated Practical Skills Therapeutic Education offers such a ‘holistic’ approach.

THE WHOLE IS GREATER THAN THE SUM OF ITS CURRICULUM

The new *National Autism Indicators Report: Transition into Young Adulthood* concludes that 'approximately one in four young adults with autism … never saw or talked with friends and were never invited to social activities within the past year … over one-third of young adults with autism do not transition into either employment or continued education between high school and their early 20s – a problem that poses both financial and social costs to society, families, and individual well-being. (Roux et al 2015)

A practical skills therapeutic education approach is increasingly found to redress this situation.

In 2010, The British government's Office for Standards in Education (Ofsted) inspection report described:

'*Ruskin Mill College has outstanding success in developing students' practical craft and land-based skills. Students have excellent successes in achieving a range of national awards. They develop highly effective communication and personal skills which enable them to participate confidently as valuable members of the wider community.*' The inspection report judges the college as having an '*outstanding learning community*' with the curriculum '*designed coherently around the principles of therapeutic education and of learning through crafts in a biodynamically managed landscape*.' The students '*take part in every stage of production, from preparing the raw material to the final product.*' (Ofsted, 2010) Four years later, in judging 'Outcomes for learners' Ofsted concluded: '*The great majority of students progress successfully to their chosen and projected destinations …The standard of students' work is good and sometimes outstanding, particularly in the practical subjects such as welding, where the students produce items to industry standards*.' (Ofsted 2014)

Within such government assessments lie several fundamental factors that are increasingly found to potentiate cognitive, social, emotional, intellectual and physical functioning in young people. Moreover, while these factors are beneficial in remedial education, they are equally important in mainstream education.

The practical curriculum has been found to confer more than the skills learned. Research from unrelated diverse disciplines indicates that practical skills-based education develops a more general capacity to function and work in other areas. In other words competencies are transferable in a broad sense:

"*Craft courses score highly in terms of providing students with creativity, independence, determination and problem-solving skills. Crucially they provide them with craft knowledge, which* ***can be applied broadly***."

"*Research into the working lives of graduates from craft-based courses revealed that: Craft activity is far richer, far more diverse, far more complex and far more empowering than our old out-dated models of craft practice suggest. There is a new economy in the making.*" (Press and Cusworth, 1998)

It is not a coincidence that such practical curricula such as design and technology have the lowest truancy rates in the UK. It is suggested that such a curriculum connects with more young people by making the abstract more concrete. For example making jewelry involves practical hand-craft and aesthetic skills, but it has also been pointed out that it involves a knowledge of metallurgy, mathematical skills, calculations involving temperature and volume - all linked to cultural skills (O'Connor, 2007; Press, 2008).

Moreover, the role of *apprenticeships* in learning skills is increasingly recognized. Apprenticeships have been found to produce staff who are of a "higher quality" and are "more loyal … motivated and satisfied … Apprenticeships reduce staff turnover". Apprenticeships are also considered 'a key factor in cultivating capacity building and general transferable competencies in young people' (LSC, 2008).

Research in the manufacturing industries has for some time been found craft knowledge to be "a strategic resource … the contribution of crafts knowledge

and cognition as a means of stimulating innovation, of integrating expertise, and of disseminating and stabilizing learning." In evaluating a "company's strategic and competitive gain. It is concluded that crafts knowledge may constitute a powerful strategic design tool … **a unique amalgamation of cognitive, social and technical skills rather than a purely aesthetic resource."** (Yair et al, 2001) Learning craft skills has also been found to serve "**as facilitator to collaborative new product development."** (Yair et al, 1999)

Research by Sheffield Hallam University found that a curriculum rich in manipulation of materials, creativity, experimentation and design is linked to positive employment outcomes for craft-based students. The majority of these graduates got jobs in the creative sector. The longitudinal study of job destinations from ceramics, glass, fashion, textiles, jewellery, wood, metal and plastics courses showed that 75% of employment is in applied art and design-related fields. (Crafts Council, 1999).

In the study entitled *From Learning to Earning*, neither the author nor the Arts Council of England were fully aware of the neuro-cognitive implications of their assessments and recommendations for higher education, "In the transition towards a digital future it is important that an **experience of tangible 3D qualities** is maintained … Practical assignments develop visual and **three-dimensional skills and an understanding of materials and processes**. Courses are designed to encourage innovation and risk taking and to build confidence." (Burroughs, 2002)

This is part of a growing support for a practically oriented curricula which as described in a DfES study bridge 'the academic/vocational divide and produce rounded, resourceful and free thinking citizens who are also versatile in manual skills. There is hence a strong emphasis on practical skills and an objection to the premature use of ICT which, it is claimed, disempowers pupils through causing them to use computers

before they can fully understand the actions that are carried out." (Woods et al, 2005)

While the advantages of a practical skills-based education are increasingly recognized, recent research indicates that the benefits are more than just the product of the specific skills learned. "… it is evident from the discussion above that process – the conditions, pedagogy, relationships, etc. that frame student experience – cannot be neatly separated from learning" (Woods et al, 2005) This conclusion is a variation on the conclusion of other studies. For example in addressing "New paradigms for employability learning", the Higher Education Academy concludes "The new employability agenda for higher education …requires an **holistic approach** … it is not appropriate to separate employability-related projects from other learning and teaching initiatives, rather they should - in line with employability thinking – integrate within the student learning experience." (Higher Education Academy, 2003)

Recent advances in neuroscience and other fields are offering new insights into how and why a practical skills education has wider benefits than were previously expected.

3-D EDUCATION

A curriculum primarily based on practical skills-based activities cultivates precisely the cognitive and physical experiences necessary for full intellectual development. Yet, there has been increasing concern that children and young adults are spending more and more time experiencing a virtual world as opposed to a three-dimensional real world during key years of their cognitive development. This has been the result of dramatic increases in time spent in front of screen technology (ICT) (Sigman, 2012ab, 2014).

2-D Living

Today in Britain, children by the age of 10 have regular access to an average of five different screens at home, routinely engaging in two or more forms of screen-viewing at the same time. (Jago et al 2011) And viewing is starting earlier in life. Nearly one in three American infants now has a TV in their bedroom and almost half of all infants watch TV or DVDs for nearly two hours per day (Common Sense Media 2011).

Over the course of childhood, children spend more time watching TV than they do in school.((AACAP 2001) When including computer games, internet and DVDs, by age 18 the average European child will have spent three years of 24-hour days watching screen media; by the age of 80 they will have spent 17.6 years (Sigman 2012ab).

Over the last twenty years, social interaction (eye-to-eye contact) has gone down while levels of eye-to-screen-contact has gone up. Just before the year 2000, life became literally virtual: people would spend more time in front of a screen than spending time interacting with other human beings (Figure 1).

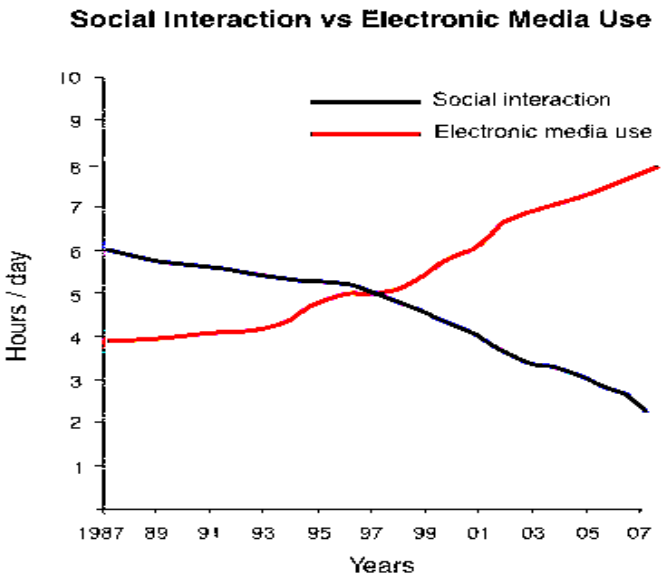


Figure 1. Hours per day of face-to-face social interaction declines as use of electronic media increases. These trends are predicted to increase (data abstracted from a series of time-use and demographic studies) (Sigman, 2009).

Across the industrialized world, watching screen media is now young people's main pastime. Children of all ages are watching more screen media than ever before (TV Licensing 2011).

Excluding any viewing time outside the home such as hand-held screen activities, the average screen time in the home for young British adolescents is now 6.1 hours per day and rising significantly (Ofcom 2011). Canadian children spend 7.8 hours per day and American children 7.5 hours: 55 per cent of their waking lives (Leatherdale et al 2011; CDC 2011). The ongoing EU-funded pan-European ToyBox-study group has just reported, 'In general, parents had no formal rules about TV viewing … Remarkably, in most countries, parents of a low SES had almost no rules regarding watching TV. Children can watch TV all day long or whenever they want.' (De Decker et al 2012)

As both intra and extra curricular time is spent in front of a two-dimensional world, the importance of incorporating a more three-dimensional component in education is beginning to appear in different areas of education.

Cognition and psychosocial learning

Regarding the potential role of screen time in psychosocial learning, it is known that younger children experience considerable difficulty when translating to real life what they see on a screen. Children learn tasks better from a live demonstration than from an equivalent televised demonstration, a problem referred to as the *video deficit*. (Zack et al 2009; 2013) This effect becomes more pronounced and may persist at older ages as the task complexity increases - and psychosocial tasks, such as perceiving and interpreting other 's actions, emotions and intentions are highly complex. This is a highly important consideration for children and young people with or without ASD where the opportunity to cultivate effective communication and personal skills is imperative for future employment and general social viability.

An Ofcom report on screen time amongst the young states that 'seven in ten play computer and video games 'almost every day, up from 59 per cent in 2010.' (Ofcom, 2011) More than a third (37%) of 10-year-olds in England play computer games for more than three hours a day. This represents an increase since 2001 and one of the highest proportions internationally, and researchers found a link between this use of computer games and lower attainment in reading and literacy (PIRLS, 2007).

In another study of 10,000 children, using a standard test of perceptions of volume and weight, considered a fairly robust indicator of cognitive development, researchers have concluded… " ... the performance of students has recently been getting steadily worse. An 11-year-old today is performing at the level an 8- or 9-year-old was performing at 30 years ago… in terms of cognitive and conceptual development … It's a staggering result, … The idea that children leaving primary school are getting more and more intelligent and competent is put into question by these findings …The most likely reasons are the lack of experiential play in primary schools, and the growth of a video-game, TV culture. Both take away the kind of **hands-on play that allows kids to experience how the world works in practice and to make informed judgments about abstract concepts** … **Children, especially**

boys, are playing more in virtual worlds instead of *"outdoors, with tools and things …"* (Shayer, et al, 2007; Shayer, 2008).

A drop in higher-level-thinking-skills among adolescents has now been reported: 14-year- olds today exhibit the higher level thinking skills of 12 year-olds thirty years ago. Half as many 14 year-olds now exhibit higher level (interpretive) thinking as opposed to quick (descriptive) thinking. The researchers believe "Everything in the past 30 years has speeded up. It's about reacting quickly but at a shallow level ... text messages and computer games are about speed and instant hits, rather than more profound or detailed ways of handling information.' (Shayer & Ginsburg 2009)

Regarding the daily time available for children and young people to learn psychosocial skills through face-to-face interactions, studies at Stanford University have led to a 'displacement' theory of Internet use:

In short, no matter how time online is measured and no matter which type of social activity is considered, time spent on the Internet reduces time spent in face-to-face relationships... an hour on the Internet reduces face-to-face time with family by close to twenty- four minutes. (Nie et al 2005)

Even economists are measuring recreational screen time and the decline in direct human contact referred to as the 'Economics of Digitization'. In the study '*What Are We Not Doing When We're Online*' A research economist at the Technology Policy Institute reported that 'new activities, like social media, have an opportunity cost in terms of activities crowded out…. each minute of online leisure time is correlated with 0.29 fewer minutes on all other types of leisure,' including 'from (offline) socializing, 0.04 minutes from relaxing and thinking, and the balance from time spent at parties, attending cultural events … working, 0.12 fewer minutes sleeping, 0.10 fewer minutes in travel time, 0.07 fewer minutes in household activities, and 0.06 fewer minutes in educational activities.' (Wallsten 2014)

An ongoing study of family interaction today by the University of California–Los Angeles has measured things such as “physical proximity in home spaces” and reported that “family members seldom came together as a group.” Children were found alone in almost 35 per cent of observed cases, the main activity being screen viewing. They concluded that social disengagement is now rapidly increasing, as eye-to-eye parent-child interactions are being displaced by the eye-to-screen relationship (Campos et al, 2009).

Neurobiology of socialisation

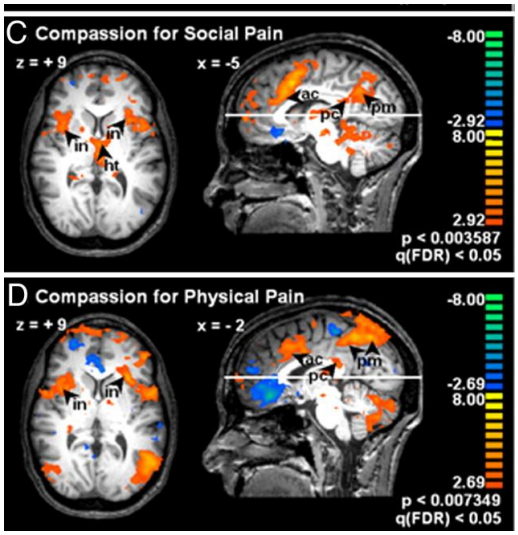
We know that if children do not exercise key muscles certain weaknesses will emerge later. There may be a similar process, which applies to certain brain areas. It may be that children must exercise specific brain areas and systems regularly and extensively in situ, in order to develop crucial social and emotional skills or deficits will emerge later.

The development of empathy and compassion requiring subtle skills of reading the nonverbal nuances of others’ emotions involve similar learning processes, which appear to have a neurological basis. For example, the brain’s insular cortex has been identified as a key brain mechanism involved in experiencing the emotional states of others and is thought to underlie egalitarian behaviour in humans.(Dawes et al 2012) Feeling empathy for a friend’s emotional suffering activates ‘affective pain regions’ in the brain associated with having firsthand experience of the same suffering.(Meyer et al 2012) The learning effects of routinely experiencing such social emotions are reflected neurologically. The ‘deliberate cultivation of compassion’ through ‘compassion training’ for empathic responses to other people is associated with changes in ‘functional neuroplasticity’ in the brain. (Klimecki et al 2012)

At the same time, researchers conducting functional magnetic resonance imaging (fMRI) research have expressed concern that when using the internet, for example, the areas of the brain associated with empathy showed virtually no increase in stimulation, concluding ‘Young people are growing up immersed in this technology and their brains are more malleable, more plastic and changing than with older brains ... As the brain evolves and shifts its

focus towards new technological skills, it drifts away from fundamental social skills.'(Immordino-Yang et al 2009; Small 2008)

Brain areas (orange) active whilst experiencing feelings of compassion:



(Immordino-Yang et al 2009)

Some insight into the potential consequences of excessive DST may be seen in the study 'Deficits in early-stage face perception in excessive internet users' which found that 'Excessive Internet use is associated with a limited ability to communicate effectively socially, which depends largely on the capacity for perception of the human face …These data indicate that excessive Internet users have deficits in the early stage of face-perception processing'
(He et al 2011)

Another way of looking at the issue is provided by the recent study 'Five days at outdoor education camp without screens improves preteen skills with nonverbal emotion cues'. The authors wrote, 'Conclusions: … skills in reading human emotion may be diminished when children's face-to-face interaction is displaced by technologically mediated communication.' (Uhls et al 2014)

The new National Autism Indicators Report: Transition into Young Adulthood found that 'approximately one in four young adults with autism were socially isolated, meaning they never saw or talked with friends and were never invited to social activities within the past year.' They believe this has

significant implications as ‘social and community participation opportunities often result from connections formed from work and continued schooling, so these opportunities may be absent in disconnected youth’. Only 36 percent of young adults on the autism spectrum attended postsecondary education, including vocational/technical schools, 2-year and 4-year colleges, at some time between high school and their early 20s. (Roux et al 2015)

Being there: co-presence

Humans require a certain amount of ‘co-presence’—regular eye-to-eye contact for optimal physical and mental health. (Holt-Lunstad et al 2010) Moreover, the fundamental ability to relate to others is dependent on social and emotional skills that are learnt through *regular* social interaction. Face-to-face conversations confer linguistic skills, along with the ability to have conversations—to know when and how to listen and contribute. This learning process is highly technical and time consuming. (Abu-Akel 2002) For example, during face-to-face interaction, in addition to hearing a voice and accompanying facial expressions of the speaker ’s face, the speech sounds produce tiny bursts of aspiration—air pressure which hit the child’s skin—tactile information contributing to auditory perception.(Gick & Derrick 2009)

Emotional development involving key bonding hormones is also enhanced through real-time voice conversation as opposed to instant-messaging. The study ‘*Instant messages vs. speech: hormones and why we still need to hear each other*’ published in the journal *Evolution and Human Behavior* monitored girls’ stress and bonding hormones (cortisol vs. oxytocin) when they were put under emotional stress. The children could then either instant message their mothers, speak on the telephone to their mothers, speak in person with their mothers, or have no interaction with their parents at all. The researchers reported ‘We discovered that unlike children interacting with their mothers in person or over the phone, girls who instant messaged did not release oxytocin; instead, these participants showed levels of salivary cortisol as high as control subjects who did not interact with their parents at all.’ (Seltzer et al 2012)

The role of oxytocin in social engagement is of growing interest. For example, Lane et al (2013) reported that ‘oxytocin increases willingness to socially share one's emotions’. Others report ‘oxytocin Improves “Mind-Reading” in Humans’ (Domes et al 2007) In their study ‘Oxytocin Increases Retention of Social Cognition in Autism’, Hollander et al (2007) administered intravenous oxytocin to adults with autism or Asperger’s and found that they ‘retained the ability to accurately assign emotional significance to speech intonation on the speech comprehension task … oxytocin might facilitate social information processing in those with autism.’

Given the importance of potentiating co-presence and social interaction amongst all young people especially those with ASD, it is imperative to consider discretionary screen time in ASD.

ASD and screen use

Studies of children with ASD are finding a more pronounced attraction to screen overuse. The title of one study encapsulates the issue ‘Adolescents with autism spend free time using solitary, screen-based media’. (Mazurek et al 2011)

A new study in the *Journal of Autism and Developmental Disorders* reported on ‘Television, Video Game and Social Media Use among Children with ASD and Typically Developing Siblings’. The researchers noted "*Children with ASD may be attracted to video games because they can be rewarding, visually engaging and do not require face-to-face communication or social interaction. Parents need to be aware that, although video games are especially reinforcing for children with ASD, children with ASD may have problems disengaging from these games.*" (Mazurek & Westrup 2013)

Another study entitled ‘Video Game Use and Problem Behaviors in Boys with Autism Spectrum Disorders’ published in *Research in Autism Spectrum Disorders* found that such boys ‘are much more likely to develop problematic or addictive patterns of video game play.’ ((Mazurek & Engelhard 2013)

Still other recent studies report ‘strong associations between internet addiction … and autism-traits.’ (Romano et al 2013).

Due to the emphasis on ‘real-world’ 3-D learning, co-presence, mentoring and social interaction a practical skills therapeutic education is likely to minimize this risk and potentiate social engagement. For example, the most recent report by Ofsted on Ruskin Mill Trust’s Freeman College noted: ‘All learners make significant gains in personal, social and communication skills and in improving their self-confidence and behaviour.’ (Ofsted 2012) Regarding Ruskin Mill College, Ofsted noted that ‘*Students develop their social skills well. They greatly increase their ability to make confident choices, communicate more effectively and begin to manage their own behaviour’. (*Ofsted 2014)

EDUCATIONAL TOOLS

Years later the importance of incorporating a more three-dimensional component in education is being observed in the work place. Senior engineers and car mechanics have noted that **there has been a recent and noticeable decline in the ability of junior engineers (at a major US national scientific laboratory), and apprentice or work placement mechanics to conceptualise straightforward mechanical problems.** It was observed that while the young people concerned had more than enough intelligence to do the work, they seemed to have missed certain areas of cognitive development because “they hadn’t held a spanner or tinkered with a simple engine”. (Wilson, 1999) These have been seen as the **first signs of a software-instead-of-screwdriver-society** and there are neurological reasons why working with one’s own hands in a real-world 3-D learning environment is imperative for full cognitive and development.

The vital role of using hands and tools appears to be deeply embedded in our development not only as individuals but as a species. The evolution of the hand—particularly the opposable thumb—was key to the success of early humans. Without a precise grip, involving forceful opposition of thumb with fingers, tool technology could not have emerged. Moreover, human-like precision hand use appears to have occurred long before our species evolved. A new study published in *Science* entitled Human-like hand use in Australopithecus africanus reports 'evidence for stone tool use in australopiths and provide morphological evidence that Pliocene hominins achieved human-like hand postures much earlier and more frequently than previously considered. Modern human-like hand postures consistent with the habitual use of tools appeared about half a million years earlier than the first archaeological evidence of stone tools.' (Skinner et al 2015)

New neuro-scientific research such as *The Neural Bases of Complex Tool Use in Humans* (Johnson-Frey, 2004) is finding that using tools such as those in craft activities, involves the use and strengthening of "*widely distributed, yet highly interactive, [brain cell] networks. Furthermore this tool use - described as "complex, real-world behaviors*" - involves and stimulates "*social, cognitive, perceptual and motor processes*." By using tools in this way, *mirror neurons* - specialised brain cells involved in observational learning and/or copying by example (e.g. metal forging) - are activated. This is part of a greater civilizing process, which serves "***as a critical mechanism for the cultural transmission of skills.***"

The same phenomenon has been found in a study of primates entitled, *When Pliers Become Fingers in the Monkey Motor System*. The study, published in the Proceeding of the National Academy of Sciences, describes, "*The capacity to use tools is a fundamental evolutionary achievement.*" Using tools activated mirror neurons involved in learning through observation. But tool use also seemed to 'integrate' the learning activity in a physiological way "as if the tool were the hand of the monkey and its tips were the monkey's fingers." The brain's trick is to treat tools as just another body part. When a primate learns to use a tool, its brain must code brain cells not only to move the hand but

also to make the tool manipulate an object, a much more cognitively complex task. (Umiltà et al., 2008) And perhaps a ‘3-D’ lesson to be remembered in educational policy making today. Tool use involved in a practical skills education appears to ‘exercise’ the brain in a variety of ways that go far beyond the capacities used for the specific task at hand.

Mirror Neurons in Autism Spectrum Disorders

Stimulating the brain’s mirror neurons in people with ASD, including Asperger syndrome, is of growing interest to neuroscientists. Impaired social function is a cardinal symptom of autism spectrum disorders. As Professor Maria Urbano of Eastern Virginia Medical School describes it, ‘What makes this important is you might have someone with a 125 or 130 IQ who's unemployable" because of their social impairments’. (Urbano 2010) Preliminary employment studies indicate that young people with ASD may earn less and be employed at a lower rate compared to other people with disabilities (Standifer, 2011).

One of the brain circuits that enable us to relate to other people is the mirror neuron system. As described above, this brain circuit is activated when we watch other people, and allows our brains to represent the actions of others, influencing our ability to learn new tasks and to understand the intentions and experiences of other people. However, the mirror neuron system is impaired in individuals with ASD. For example, compared to the mirror neuron systems of typical people, the mirror neuron system in ASD individuals becomes less activated when watching the hand gestures of other people. In addition, among people with ASD, less mirror neuron activity is associated with greater social impairments (Enticott et al 2012). Further refinement of the potential suppression of mirror neuron activity in ASD has recently been published in *Brain Research.* The researchers ‘question the claim of a global dysfunction of the MNS in autism’ and suggest that when monitoring mirror neuron activity using Electroencephalographic (EEG) techniques, mirror neuron rhythmic activity may be suppressed more specifically ‘in the upper sub-band over the sensorimotor cortex’ (Soussignan et al 2014).

An interesting study published in *Biological Psychiatry* reported that the mirror system in individuals with autism is not actually broken, but simply delayed. Researchers believe "While most of us have their strongest mirror activity while they are young, autistic individuals seem to have a weak mirror system in their youth, but their mirror activity increases with age, is normal by about age 30 and unusually high thereafter." (see Figure 2)

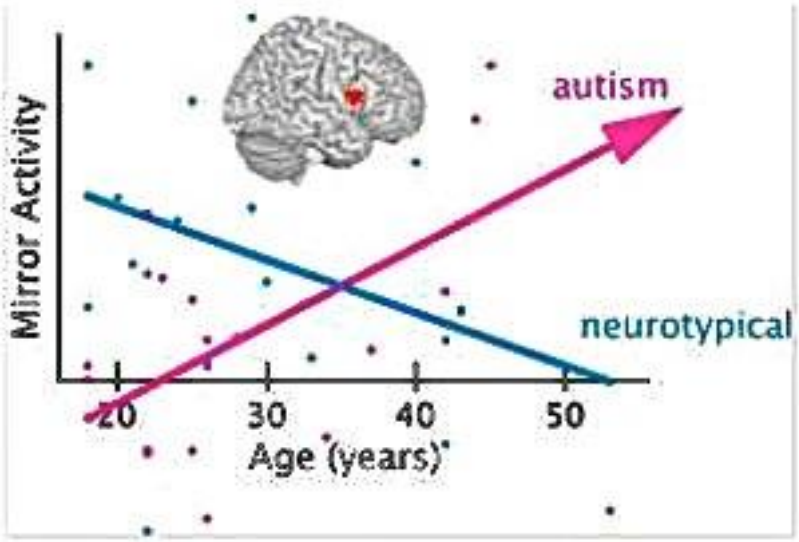


Figure 2: The relationship between age and mirror neuron activity for a typical brain and one with autism.

This increase in function of mirror neuron systems may be related to increased capacity for social function or **responsiveness to rehabilitative treatments** among individuals with autism. "The finding of late developing circuit functions could be very important." (Jojanneke et al 2011)

Studies are moving on to examine how individuals with autism accomplish this improvement over time, and how therapeutic interventions targeting the same mechanism can help to support this important process. The lead researcher of a new study on mirror neurons in ASD states, "We are currently investigating whether non-invasive brain stimulation can be used to improve mirror neuron activity in autism spectrum disorder, which would have substantial potential therapeutic implications." (Enticott et al 2012)

The integrated practical skills therapeutic education advanced by the RMET may, in effect, be providing a greater degree of stimulation to the

mirror neuron systems of young people. And this may underlie the conclusion of the recent Ofsted inspection report (2010) mentioned above, '*They develop highly effective communication and personal skills which enable them to participate confidently as valuable members of the wider community.*'

Even in a computer-driven world, these 3-D practical skills are an integral part of the most cutting edge international space-age technologies. The International Space Station, a joint collaboration between America, Russia, Europe, Japan, Canada and Brazil, is the most expensive object ever assembled by mankind. The £70billion structure - a giant network of pressurised cabins, solar panels and radiators - is now in its tenth year of construction yet still is only about 70 per cent complete. The design, development and construction of the Space Station were dependent on a **profound understanding of the three-dimensional real world, along with skills of classic hand use of tools**. And it is still dependent on these skills both inside the station and out (NASA/ISS, 2008). Recently, the crew of the Space Shuttle Endeavour carried out a record five spacewalks on their arduous 12-day visit to the 200ft-long space station. The entire project relies on highly educated astronaut 'mechanics' hanging precariously 250 miles above the Earth working on the exterior components of the International Space Station as it hurtles through space at 17,000mph. Perhaps it's hardly surprising that newspapers reacted to these photographs with headlines such as "Just don't drop the spanner."

Albert Einstein stated, "Learning is experiencing. Everything else is just information," suggesting that we must "experience" learning by utilizing our numerous (not just five) sensory systems. Human beings have an innate need to see, touch, taste, feel, and hear (experience) the features of any new object in order to understand it better.

Most human beings find learning easiest when they begin a learning experience with a hands-on, minds-on activity. At nearly all stages of life, one learns a great deal about our environment (objects, another person, etc.) via

our universal human preference “to touch to learn” more about an object. While touching an object, most higher order mammals will also turn it, twist it, view it from a number of other positions, etc., as a means of drawing out the most meaningful clues, cues, and relevant information needed for arriving at conclusions concerning the object. Teenagers and young adults learn in the same way.
A clear example of this process can be observed in the ‘whole-body’ learning involved in the process of making copper ware. [This author underwent a tutorial and confirmed the need to use a variety of cognitive and perceptual skills, groups of fine muscles while allocating sustained attention to the task at hand.]

The decline in a more practical hands-on component to curricula is clearly cited as a reason for the “*Declining Interest in Engineering Studies at a Time of Increased Business Need*” (Johnson & Jones, 2006). This major study found “The numbers of students studying engineering have declined in recent years, both in the United States and in Western European countries.” The study identifies the problem of abstract concepts being taught without “*putting this preparatory work in the* ***context of engineering applications****. This is typically followed by challenging engineering science courses– but often with little* ***applied experience*** *to bring into the classroom for motivation.*” The authors ask, “What can be done in education?” They point to the National Academy of Engineering (2005) which has recommended more practically-based curricula and that colleges now “Make the curriculum more user-friendly e.g., concentrate on *how* to learn rather than trying to cover everything in an intense four year curriculum ... substitute **active learning** for formal lectures.”

HANDY LESSONS

The Assessment of Children's Hand Skills is a new assessment designed for use with 2- to 12-year-old children with a range of learning difficulties and developmental delay including ASD. It utilises a naturalistic observational method to capture children's real-life hand skill performance when engaged at

various types of daily activities in everyday living contexts (Chien et al 2012). Hand skill performance is now seen as having clinical applications for ASD both in terms of assessing ASD and offering a therapeutic route to improvement.

Another way to consider the benefits of practical skills-based activities is by looking at the primal and central role of hands in learning and creation, and our evolution and survival. New thinking in evolutionary neurophysiology is suggesting that the emergence of human cognitive abilities may be the result of physical hand movements and tool use, enabling brain pathways to develop that helped language develop, with some believing that language was originally gestural. New research has also found that young children instinctively use a 'language-like' structure to communicate through hand gestures and that 'typically developing young children spontaneously organize their gestural communication systems into more segmented and linear forms.' Children's gestures were found to segment information and reorganise it into language-like sequences. (Clay et al 2014)

There are many parallels between tool use, hand movements and language for recognition, imitation and gestural communication, (learning and social behaviour) suggesting that **they rely partially on large, common brain networks, in particular mirror neurons**. Human speech and language could have evolved by co-opting neurophysiological mechanisms involved in the organisation of manipulative hand actions (Steele et al, 2012).

In chimpanzees scientists have reported a link between their ability to aim and throw missiles and their ability to communicate. They went on to find specific brain structures that appeared to underlie these skills: 'a correlation between aimed throwing ability and white-to-grey matter ratios' in key areas (Hopkins et al 2012).

It is proposed that the abstract cognitive functions of the brain's inferior parietal cortex in humans derive from an expansion of brain areas originally involved in computing sensorimotor transformations for hand use.

Furthermore **tool use leads quite literally to the learned incorporation of the tool into the body schema: the tool becomes an extension of one's own body**. This can be seen in the learning- induced changes in the cortical micro-architecture in the brains of monkeys trained in tool-using tasks. The evolution of increasing cognitive abstraction in tool use is thought to have lead to novel mental functions that are detached from body constraints – i.e. thinking outside the body (Iriki & Taoka 2012).

Frank R. Wilson, a neurologist at the University of California School of Medicine considers the hand as a 'musculoskeletal organism' emphasising the centrality to intelligence of our human hand and **how crucial the manipulation of the hands are to cognitive learning.** The hand should not be regarded as a mere 'appendix', but rather, a fundamental part of the way we create (Wilson, 2005a,b).

The human hand is a highly evolved mechanism responsible for the high level of adaptation and survival in humans. The **hands are particularly sensitive to perceiving and transmitting exceedingly sophisticated information to the brain** (Bensmaia et al, 2008) This is why Braille is not read using one's forearms or feet. The hands are heavily over-represented in many different areas of the brain. For example, there is a large area of cortex devoted to sensation in the hands, while the back has a much smaller area.

The inter-relationship between the hand and brain constitutes an integrated system, which seems genetically programmed. **The learning brain receives high levels of vital information through the sensations and movements of the hands (Bobich et al, 2007).** In fact research on 10-week-old foetuses indicates that nerve connections from the hands to the brain develop before the connections that allow the brain to control the hands. And the foetus's **hand movements appear to influence the way the brain physically develops** in the womb (Hepper & Wells, 2005). Thereafter as young adults, hand movements and brain activity are powerfully joined-up creating a 'movement profile'. **Elements of hand use such as movement velocity, direction and mode of coordination in craft activities are reflected in**

‘robust’ brain activity (Fuchs et al, 2000). Sequential finger movements activate massive regions involved in thinking, language and working memory—the system for temporarily storing and managing information.

Haptic processing

One of the key processes underlying the kinesthetic somatic component of a practical skills therapeutic education could be described as *haptic perception* - the process of recognizing objects through touch. In addition to the four kinds of mechanoreceptors there are also other receptors that provide information about sensory inputs from the hand. These include receptors specialized for pain (two kinds), temperature (two kinds), itch (one kind) and four kinds located in the muscles, tendons and joints that provide information about body position, movement and force. Together these afferents provide a rich multidimensional brain image of the size, shape, texture, and temperature of objects that we hold and manipulate with our hands. There are 13 different kinds of hand-to-brain nerve fibers each with specialized receptor endings that allow them to encode information about different sensory activity from the hand. Eight of the 13 provide information that is important for haptic perception; four of these provide information about discriminative touch and four provide information about body position and movement. This is thought to culminate in a dynamic representation in the brain of the spatio-temporal profile of stimuli in contact with the skin along with a dynamic representation of the positions, movements, and forces of our limbs, digits and joints. (Hsiao & Yau 2008)

At a time when there is increasing emphasis on visual information and processing in communication and learning, it is important not to forget the role of haptic processing. In reviewing 'The neural basis of haptic object processing' researchers believe 'Like vision, haptic processing pathways are organized into a hierarchy of processing stages, with different stages represented by different brain areas.' (James et al 2007)

Other researchers examine *haptic memory,* used regularly in crafts or practical skills learning when assessing the necessary forces for gripping and interacting with familiar objects. Haptic memory may also influence a student's interactions with novel objects of an apparently similar size and density. As with haptic perception, there are strong links between the visual and the haptic: 'a variety of similarities between visual and haptic object recognition suggests that the two modalities may share common representations…. and indicate that crossmodal memory for objects must be at least partly based on common perceptual representations." (Craddock & Lawson R 2009)

Motor skill learning induces actual structural and functional changes in the brain (Kleim et al., 2004; Rosenkranz et al. 2007a). This hand-to-brain relationship is so strong that the journal of the American Academy of Neurology reported that hand stimulation can be used to therapeutically improve brain function in adults (Rosenkranz et al, 2008). A further study published in the *Journal of Neuroscience* involved a collaboration between the Institute of Neurology, and London Hand Therapy centre. It is believed that disordered motor control in musician's dystonia is a consequence of the disordered sensorimotor organisation (SMO) in the brain's motor cortex. Subjects in the study who underwent proprioceptive hand stimulation training exhibited 'restored SMO towards that seen in healthy pianists. Crucially, motor control of the affected task improved significantly'. (Rosenkranz et al 2009) A new systematic review on 'The effectiveness of proprioceptive training for improving motor function' published in *Frontiers in Human Neuroscience* reported 'a mean improvement rate of 26%' for *healthy* adults. Regarding the *therapeutic* application, the authors report 'In summary, therapeutic success through proprioceptive training was achieved in a variety of neurological and orthopedic diseases. … it is apparent that proprioceptive training can be beneficial for rehabilitation of neurological based injury such as stroke, Parkinson's disease and dystonia, and also for musculoskeletal conditions.' In explaining the improvements, the authors conclude 'In summary, there is increasing evidence that proprioceptive training is associated with reorganization within the [brain's] sensorimotor cortex and supplementary motor area.' (Aman et al 2015)

Using the hands for arts and crafts does more than merely stimulate brain areas that control hand and arm movements. Using Functional Magnetic Resonance Imaging (fMRI) to monitor the brain of a skilled portrait artist and of a non-artist as each draws a series of faces, neuroscientists reported “a discernible increase in blood flow in the right-posterior parietal region of the brain for both the artist and non-artist during the task, a site normally **associated with facial perception and processing**.” (Solso, 2001)

Recently, a number of studies have gone on to examine how different ways of using the hands may have profound effects on how individuals think. For example, writing, rather than typing, activates different parts of the brain. Children express more and better ideas writing in cursive as opposed to typing. More of the areas of the brain associated with memory formation are activated when writing than when typing. This appears to have consequences. Research at Princeton recently published a group of studies entitled *The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking* and reported that 'even when laptops are used solely to take notes, they may still be impairing learning because their use results in shallower processing. In three studies, we found that students who took notes on laptops performed worse on conceptual questions than students who took notes longhand … detrimental to learning … even when allowed to review notes after a week’s delay, participants who had taken notes with laptops performed worse on tests of both factual content and conceptual understanding'. (Mueller & Oppenheimer 2014)

One reason for this may be the type of brain activation evoked by manual handwriting rather than typing. And writing, because it is slower and more effortful, requires one to process information more deeply. Several researchers have found that writing in cursive and printing also involve different brain processes which in turn may lead to different forms of thought. Many of the curriculum activities contained in the Ruskin Mill approach of practical skills therapeutic education require hand use facilities such as estimation, adjustment, fine motor skills, spatial ability and imagination.

These processes may lead to different ways of thinking and therefore have a transferrable quality to other areas of intellectual and professional development.

Playing with toys like blocks and puzzles has recently been reported to foster the development of strong spatial abilities. Strong spatial abilities predict better math skills. Deciding whether a block goes over or under another block, or whether it is aligned or perpendicular to it, are precisely the kinds of skills that support later learning in science, technology, engineering and math These spatial abilities help us learn math and science. Learning practical skills such as crafts has very similar functions. Children from a lower socio-economic background are already falling behind in math skills areas by 3 and 4 years of age. Researchers now believe that this achievement gap may be narrowed considerably by increasing children's experience in spatial assembly by playing with blocks and similar physical toys i.e. practical skills activities. (Verdine et al, 2013, 2014)

The underlying processes with playing with blocks and toys may be the same described in the research on writing by hand. Using hands requires the development of particular areas of the brain. This applies when humans are learning to use a tool, like our ancesters weilding an axe, when learning to play piano, to write, or to sew or play with blocks. One of the educational benefits of replacing some screen-based activities with doing something that requires greater flexibility in the way people use their hands is that it also requires greater flexibility in how they use their brains which may lead to brains developing in novel ways.

It is now thought that only by manipulating real objects in real space, that an evolutionary imperative is satisfied. And this is why **'hands-on' exploration seems critical for the development of understanding and inventiveness.**

Wilson concludes - and few scientists disagree - that "*People suffer when they separate themselves from the world of real objects, or from their instinctive responses to particular objects, materials or tools in their own hands*." He is

concerned by a shift in educational policies, which reduces the role of working with hands and removes woodwork, metalwork, music or car mechanics from the educational curriculum. Almost a decade ago he stated, "*We have begun a huge educational experiment without knowing any of the consequences.*" Subsequent research by others now gives him license to say, "I told you so". (Wilson, 1999)

'WHOLE-BODY' LEARNING

On a daily basis, an integrated practical skills therapeutic education involves a great deal of general body movement and physical activity. And as is the case with hand movement and tool use, general body movement and physical activity has profound cognitive and intellectual implications for students.

The need to move has a long history. Five hundred million years ago the nervous system first enabled coordinated movement allowing an organism to find food, instead of waiting for the food to come to it. Yet, today, lack of movement is literally killing us and it's been predicted that a new generation will die younger than their parents due to a *lack* of movement. One of the most dangerous activities in our day could be lurking right below us. Studies increasingly find that sitting for prolonged periods of time has many negative effects. Numerous, well-designed studies continue to find a highly significant dose-response association between sitting down and risk of type 2 diabetes, cardiovascular disease (CVD) and all-cause mortality among adults. A recent British study reported that every one hour per day increase in sitting down (e.g. watching TV) was associated with a 6 per cent increased risk for suffering fatal or non-fatal CVD and an 8 per cent increased risk for coronary heart disease (Wijndaele et al 2011). The practical skills curriculum does not involve the high proportion of sedentary time occurring in most arenas of school and college learning thereby mitigating these detrimental effects.

In our culture, movement has been consigned to a history of more primitive times. In education, movement is associated with 'vocations', crafts or recreation such as sports or dance. And physical development has

traditionally been considered as something ‘apart’ from other areas of learning.

However, new research shows that we can’t shake off our physical past if we want our young people to have an intellectual future and employment. Movement is inextricably linked to brain development that goes far beyond mere hand-eye coordination. Our evolution and preeminence as a species were the result of it. **While society’s main concern is young obesity,** new research indicates that physical activity (PA) may yet be the key to reducing pupils’ waist size whilst literally increasing their brain size along with their school achievement. Moreover, physical movement skills are increasingly thought to be linked to academic and intellectual performance. Physical development affects many components of a child’s development for example in language and communication, yet the process doesn’t appear to work the other way round. Physical Literacy is described as the mastering of fundamental movement skills and fundamental sport skills that permit a child to read their environment and make appropriate decisions, allowing them to move confidently and with control in a wide range of physical activity situations. The Canadian government states ‘Just as kids need to develop their reading and writing literacy, they also need to develop their physical literacy.’ (Government of Albert 2015)

A recent study published in *Medicine & Science in Sports & Exercise* found that poor motor performance was linked to poor academic skills in children’s first school years. (Haapala.et al 2014) Previous research at the University of Auckland examined perceptual motor programs (PMP) in education involving the integration of sensory input (visual, auditory, and kinesthetic) with fine or gross motor responses. The general opinion of all judges involved was that encorporating this more holistic PMP element in education ‘builds on competency in foundation skills for new entrant children that are critical to ensuring a readiness to learn and overall success at school… exhibiting behaviour conducive to learning. Social confidence when interacting with peers and adults … there is an impact on engagement with learning and behaviour.’ (Pieri 2011)

Autistic children with better motor skills have been found to be more adept at socializing and better at "daily living skills," such as talking, playing, walking, and requesting things from their parents. Research involving Cornell University's Medical College concluded that 'fine and gross motor skills are significantly related to adaptive behavior skills in young children with autism spectrum disorder.' When addressing how to implement early intervention and rehabilitation for young children with autism, the authors now believe 'motor skills need to be a part of the discussion.' The author's added '"Motor skills are embedded in everything we do, and for too long they have been studied separately from social and communication skills in children with autism … Motor skills and autism have been separated for too long." (MacDonald et al 2013ab)

A study published in *Brain Research* has found an association between physical fitness and the brain anatomy in children: Those who were more physically fit tended to have a bigger hippocampus - about 12 percent bigger relative to total brain size -- and perform better on a test of memory than their less-fit peers. The hippocampus is important in learning and memory and a bigger hippocampus is associated with better performance on spatial reasoning and other cognitive tasks. (Chaddock et al 2010)

The American Heart Association reported that children who are aerobically fit 'over time score the highest mean on all the academic subtests'. Conversely, those who were not fit 'obtained the lowest academic mean'. The researchers see significant academic implications for PA in the school system, saying "if we can intervene on those children who are not necessarily fit and get them to physically fit levels, we may also see their academic performance increase." (Cottrell et al 2010)

And the brain v brain issue takes another twist in a study of 1.2 million Swedish male teenagers published in the *Proceedings of the National Academy of Sciences*, which found that young people who are fit have a higher IQ and are more likely to go on to university. But it is only

cardiovascular (CV) fitness, not muscle strength, that plays a role in the IQ test results, CV fitness is thought by the researchers to ensure that the brain gets plenty of oxygen. The study also found that teenagers who improve their physical fitness between the ages of 15 and 18 increase their cognitive performance when measured at age 18: “These data substantiate that physical exercise could be an important instrument for public health initiatives to optimize educational achievements.” (Åberg et al 2009)

A systematic review entitled ‘Physical Activity and Performance at School’ published in the *Archives of Pediatrics & Adolescent Medicine* takes the concept of PA and intellect further with the author commenting "we found strong evidence of a significant positive relationship between physical activity and academic performance.” (Singh et al 2012) PA is thought to help a child’s cognitive processing by increasing blood and oxygen flow to the brain, increasing levels of norepinephrine and endorphins to decrease stress and improve mood, and increasing growth factors that help create new nerve cells and support the connections between brain cell synapses which are at the basis of learning.

The underlying mechanisms are being identified. Studies of brain function at the Medical College of Georgia on children have just found a direct, positive relationship between their level of PA and their level of frontal-lobe brain activity (blood flow), an important area for intellectual executive function. Furthermore, these brain changes correspond directly, in a ‘dose response’ pattern, with positive changes in pupils’ cognitive test scores assessing their decision-making processes and math achievement. The authors commented “We hope these findings will help persuade policymakers, schools and communities that time spent being physically active enhances, rather than detracts, from learning.”

The new study ‘Childhood aerobic fitness predicts cognitive performance one year later’ found, in addition to higher scores, that fitter children ‘gained a speed benefit’ in performing cognitive tests a year later. Interestingly, the size of the brain’s basal ganglia was implicated in better cognitive performance.

The researchers echo the sentiment: ‘We hope that this research will encourage public health and educational changes that will promote a physically active lifestyle in children.’ (Chaddock et al 2012)

Research on how PA actually changes our neurobiology is now very specific. Scientists have long known that regular PA increases the number of sub-units in muscle cells called mitochondria, responsible for generating energy, which in turn is thought to underlie many of the positive physical effects of PA. In a new study in mice, researchers at the University of South Carolina have discovered that regular PA also increases mitochondrial numbers in *brain* cells, a potential basis for beneficial intellectual effects associated with PA. (Steiner et al 2011)

A study which compared levels of physical activity between children with autism spectrum disorders and children without disabilities has found that those with ASD were less active during free periods in school and playground time (Pan 2008). Yet, at the same time, PA appears to provide short-term reductions of stereotypic behaviours in young people with ASD. Furthermore, benefits were not limited to these stereotypical behaviours; several studies have found improvements in other areas for those with ASD (Petrus et al 2008).

And so the ‘whole-body’ learning of a practical skills therapeutic education seamlessly keeps young people moving and physically active. This is in stark contrast to a trend of children elsewhere exhibiting a deficiency in basic fundamental movement skills. (Hardy et al 2013; Tester et al 2014)

And **the physical activity taking place within the woodland ecology, gardening, horticulture and farming components of integrated practical skills therapeutic education may afford additional benefits.** British research published in the journal of American Chemical Society's *Environmental Science & Technology* found that even small doses of outdoor physical activity can have significant effects on mental health. In ‘*What is the Best Dose of Nature and Green Exercise for Improving Mental Health? A*

Multi-Study Analysis', reaearchers found that getting outside—and moving—for as little as five minutes at a time improved both mood and self-esteem. *All* types of green physical activity led to improvements in the mental health indicators. Most surprising to the researchers was that the strongest response was seen almost immediately. “You get a very substantial benefit from the first five minutes. We should be encouraging people in busy and stressed environments to get outside regularly, even for short bits of time” said the co-author. Both healthy people and those with mental health disorders benefited, with the mentally ill showing the strongest improvement in self-esteem. 'This study confirms that the environment provides an important health service.' (Barton & Pretty 2010)

DIVERSIONAL THERAPY

Craft based activities have been employed clinically to **improve cognitive functioning** and peripheral symptoms in patients with mild to moderate senile dementia of Alzheimer type (Fumiko, 2005). Crafts are also employed under the classification of 'diversional therapy'. In Australia, this approach has it's origins in the 1940's when craft based activities were found by the Red Cross to be integral to the **rehabilitation** of servicemen and women "to **ameliorate the sufferings** of those who have become casualties, whether military or civilian"(Butler, 2000; Australian Red Cross, 2008a)

Craft-based activities were then applied to **improve the cognitive functioning** and quality of life of nursing home residents. "A 1967 pilot study, introduced diversional therapy ... Although the study was completed in three months, the programmes continued because of their proven value … For many years the Australian Red Cross trained practitioners. The National Fitness Council and New South Wales department for Sport and Recreation also provided recreation training …"(DTAA, 2003). Survivors of natural disasters have shown considerable benefit from craft-based activities which seem to work as 'diversional therapy' as well as giving the individual **a sense of control** over what they are doing which has a general effect of increasing

the person's **locus of control**. Again this 'diversional therapy' has become an integral part of the Red Cross's regional development. (Australian Red Cross, 2008a,b)

Physicians and exercise physiologists have employed craft activities to enhance athletic performance. The National Team Doctor noted that members of the of the German football team would “lie around and watch TV between training sessions, their mind assuming an almost vegetative state." To "increase their mental creativity" they were asked by the Team Doctor to study new languages and do **handcrafts**, between training sessions at the World Cup. "The results were outstanding. Modestly talented German teams advanced to the World Cup final in 1986 and 1990. When we build a training program, we have to consider the brain as well as the body." (Seiler, 1996, 2008)

LOCUS OF CONTROL

The mechanism by which craft activities produce positive effects may be in part by reinforcing and cultivating a greater sense of control within the student. The concept of *locus of control* refers to our general belief that what happens is mainly either under *our own* control (internal locus) or a matter of chance or *outside* controllable factors (external locus).

While our degree of internal/external locus of control may be powerfully influenced by behavioural genetics and our upbringing and earlier life experiences, it is still modified by our subsequent experiences (Marsiglia et al., 2007). Studies of children and adults in a variety of settings including schools, colleges and laboratories have reported shifts in the individual’s locus of control brought about by the **nature of the curriculum** and other approaches. For example the introduction of an **agro-forestry curriculum** involving student participation “*incorporating local agricultural and forestry issues in student work*” resulted in “ *student internal locus of control had increased*”. (Herbeck, 2004)

Far away from the outdoor curriculum, teaching students a skill that increases their sense of control over something – even a skill as unusual as controlling their own finger temperature – enhances their general sense of control over wider events. A laboratory-based study of 18-21 year olds found that biofeedback-assisted autogenic training (controlling finger temperature) made the young adults "*significantly more internal in their locus of control after training*". (Sharp et al., 1997).

It seems that by learning to control things in a 'hands-on' context, students gain a more general sense of control over other areas of their lives. Therefore the RMET curriculum, primarily based on practical skills activities where the learner is fully involved in all stages of the process including work with pewter, copper, metal forging, jewellery, horticulture and building projects as well as drama, appears to cultivate a greater internal locus of control in students. One practical example can be observed in the process of gold leaf gilding at Freeman College in Sheffield where the use of highly controlled 'circular' breathing is developed in the students to prevent blowing the very fine flakes of gold away.

And there are practical implications of a more balanced locus of control. A recent 26 year study from birth involving 3700 British people found that internal locus of control was "*significantly related to educational attainment in both men and women*." The study also found that "*Self-esteem predicted educational attainment in both genders by increasing internal locus of control*" (Flouri, 2006).

While an earlier study concluded, " *An important element in promoting achievement in educational environments is the sense of control or empowerment that students' perceive they have over performance.*" (Nunn and Nunn, 1993) Students with an enhanced internal locus of control may see their grades as being achieved through their own abilities and efforts, whereas those with an enhanced external locus of control may consider their grades as the product of good or bad luck, or to a tutor who constructs bad exams or grades whimsically; hence, they are less likely to expect that their own efforts

will result in success and are therefore less likely to work hard for high grades. (Rotter, 1975)

In the work place, it has been found that those with an enhanced internal locus of control are more likely to take positive action to change their jobs, rather than merely to talk about it, than those who have a more external locus of control (Maltby et al., 2007).
And once students are out in the working adult world, enhanced internal locus of control is linked with having a lower level of work-family conflicts (Boyar and Mosley, 2007)

Emotional stability, behaviour and mental health are also influenced by locus of control. A more internal locus of control is associated with an increased ability to delay gratification, tolerate ambiguous situations, or resist coercion. (Lefcourt, 1976; Rotter, J.B. 1966). While in clinical studies, enhanced internal locus has been found to have a lower association with suffering from anxiety, and a reduced risk of suffering from depression, other psychopathologies, and behavioural problems (Liu et al., 2000).

Even something medical and physiological such as the level of insulin resistance in diabetic patients is significantly lower in patients with a higher internal locus of control. (Trentoa et al., 2007) And learning about their condition in a group as opposed to individual setting was found to increase patient's internal locus of control.

From the examples above it is clear that enhancing internal locus of control is associated with a wide variety of benefits in a wide variety of groups and settings. With regard to students, a major project in the United States advises "***Instructional strategies and techniques must also be developed that will promote a sense of internal locus of control.*** *Resilient students have spoken of satisfaction gained from experiencing success in self-fulfilling activities. These activities also increase the motivation to achieve. At-risk* ***students need to have visible and concrete displays of success*** *in order for them to see the progress that has been made.*" (MERC, 2008) A high

proportion of the practical skills therapeutic education involves precisely these visible and concrete displays of success.

RE-THINKING SELF-ESTEEM

The term ‘self-esteem’ is assumed by those in education to be a unitary concept and always a good thing. But there are now grave reservations about our wholehearted embrace of bigging our young people up.

Psychometric measures of narcissism along with self-esteem in the young have risen steadily since the early 80s. A US national study of 16,475 college students concluded that today’s young are more narcissistic and self-centered than their predecessors. Two-thirds of students have above-average scores, 30 percent more than a quarter of a century ago. The researchers attribute the phenomenon to the “self-esteem movement” that emerged in the 1980s, concluding that the effort to build self-confidence has gone too far. (Twenge & Foster 2010)

A meta-analysis of seventy-two studies on empathy over 30 years involving almost 14,000 university students offers little flattery for the young: ‘College kids today are about 40 per cent lower in empathy than their counterparts of twenty or thirty years ago.’ (Konrath et al, 2010a,b; 2011) And so describing a spoilt generation is not a value judgment intended to ‘demonise young people’, merely an objective assessment.

Research on high self-esteem is now finding that there are good and bad forms. A study in the *Journal of Personality* reported that there are many kinds of high self-esteem, with the authors stating, ‘we found that for those in which it is fragile and shallow, it’s no better than having low self-esteem’. It’s now becoming clear that of the multiple forms of high self-esteem, only some consistently relate to positive psychological functioning.

High self-esteem in students does not produce better grades. It seems, if anything, it’s the other way round: getting good grades leads to higher self-

esteem. In fact, a study at Virginia Commonwealth University found that university students with mediocre grades, who received frequent self-esteem strokes from their lecturers, ended up doing worse in their final exams than students who were told to bite the bullet and try harder.

It has often been assumed that it is low self-esteem that is more likely to be a cause of violence, yet it is found that violent people often think rather highly of themselves. People with high self-esteem are likely to respond aggressively when their inflated view of themselves is threatened by criticism or perceived insult, or when someone obstructs their need for gratification. Members of gangs are found to have high self-esteem, so do wife-beaters. Violent criminals, who we've been told are 'acting out' their low self-esteem, actually have the highest scores on a personality scale of narcissism (excessive self-love). And high self-esteem has been linked to bullying. The researcher Roy Baumeister has written 'according to most of the studies that have been done; it is simply untrue that beneath the surface of every obnoxious bully is an unhappy, self-hating child in need of sympathy and praise'. High self-esteem doesn't prevent children and young people from cheating, stealing or experimenting with drugs and sex. Children with high self-esteem may be even more willing to try these things at a young age.

The American Psychological Society commissioned Baumeister and other experts to assess the benefits of high self-esteem. And Baumeister's conclusion is unequivocal:

'Here are some of our disappointing findings. … In short, despite the enthusiastic embrace of self-esteem … After all these years, I'm sorry to say, my recommendation is this: Forget about self-esteem and concentrate more on self-control and self-discipline. Recent work suggests this would be good for the individual and good for society – and might even be able to fill some of those promises that self-esteem once made but could not keep.'

Enhancing self-esteem has often focused on expressing feelings and emotions, without, at the same time, demanding self-discipline and self-

control. Other researchers too now believe that perseverance, resiliency and reality-testing, are much better predictors of life fulfillment and success than self-esteem. Young people who are repeatedly told that there is little about themselves that demands improvement are being helped to develop a distorted, socially unviable sense of self. On the other hand, parents and teachers who set realistically high expectations, criticise when it is warranted and are intolerant of egotistical behaviour and values are conferring great benefits on the young. (Sigman, 2009b)

Healthy self-esteem does not appear to be developed by being served with contrived platitudes but through experience, it is a by-product of living in a constructive way. Instead of trying to raise it directly in a young person, it's more effective to focus elsewhere (such as on what a student does) and enable self-esteem to rise as a side effect. The practical skills therapeutic education appears to incorporate these necessary elements. The apprenticeship learning and mentoring, the process of crafting, combined with the student experiencing the result of the their own efforts appears ideal approach to developing the right type of self-esteem in the right way.

SUSTAINED ATTENTION

Sustained attention and **self-regulation** are cultivated and reinforced through a practical skills-based curriculum. Many parts of the RMET curriculum, for example "craft activities where the learner is fully involved in all stages of the process" as well as drama and storytelling, cultivate sustained attention – the ability to concentrate.

The process of 'start-to-finish learning' also cultivates deferred gratification vital to impulse control. Although intelligence is generally thought to play a key role in children's early academic achievement, aspects of children's self-regulation abilities - including the ability to alternately shift and focus attention

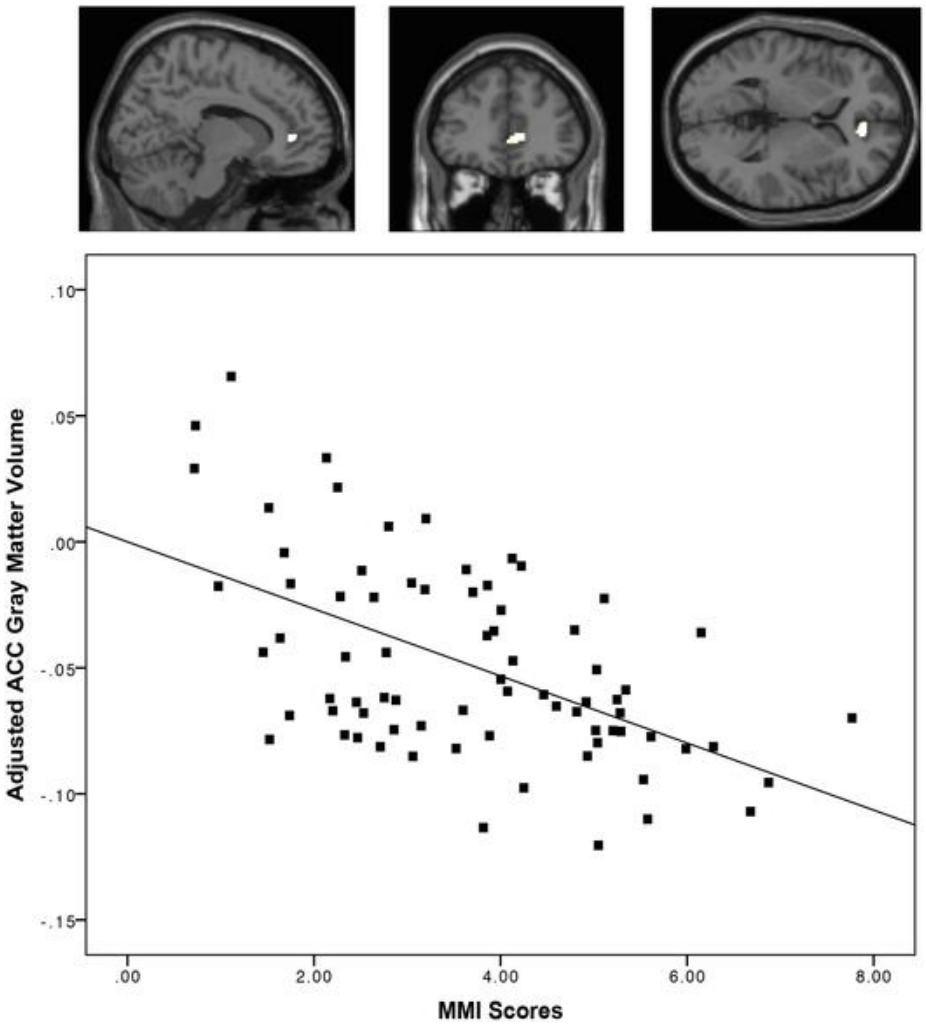
and to inhibit impulsive responding - are uniquely related to early academic success and account for greater variation in early academic progress than do measures of intelligence. Although there is currently a focus on teaching specific content and factual information even in pre-school and early primary education, these findings indicate that without a simultaneous focus on promoting self-regulation skills - to be able to sufficiently regulate attention, impulsivity - many children are likely to struggle to keep pace with the academic demands (Blair and Razza, 2007)

This distinction between sustained and divided attention is the subject of increasing concern because of the dramatic increase in younger people multitasking with different electronic media: social networking online, flicking their eyes from laptop to TV screen and back again, or flipping between channels to keep up with two simultaneous shows at once. (Kaiser Family Foundation, 2005; Childwise Monitor, 2008; Jago et al 2011)

As more young people either study with a TV on in the room or multi-task by switching their attention between different forms of electronic media or even different programs on the same screen, brain imaging now reveals that multi-tasking activates a different brain region (the striatum) to the one used when you learn one thing at a time (medial temporal lobe) and this is a significant hindrance to learning. (Foerde et al, 2006) The neuroscientists behind this research are describing the benefits of modern multitasking as "a myth ... The toll in terms of slowdown is extremely large - amazingly so ... you will never, ever be able to overcome the inherent limitations in the brain for processing information during multitasking." (Myers, 2006)

Research has recently looked at the degree of media multi-tasking that young people engage in and the size of key brain areas. The anterior Cingulate Cortex (ACC) is involved in error detection, learning and the recognition of emotional cues. A recent study entitled ‘Higher Media Multi-Tasking Activity Is Associated with Smaller Gray-Matter Density in the Anterior Cingulate Cortex’, concluded ‘individuals who engaged in more media multitasking activity had smaller gray matter volumes [brain size] in the ACC. This could also possibly

explain the poorer cognitive control performance and negative socio-emotional outcomes associated with increased media-multitasking.'
The authors state 'although it is conceivable that individuals with smaller ACC are more susceptible to multitasking … it is equally plausible that higher levels of exposure to multitasking situations lead to structural changes in the ACC.' (Loh & Kanai 2014)



Relationship between increasing media multi-tasking (MMI) and reduced gray matter (brain) density in young people. (Loh & Kanai 2014)

In the new world of greater 2-D learning, there are growing links between time spent in front of computers and television screens – a medium which erodes the ability to pay sustained attention – and learning problems, reading ability and lower academic and occupational achievement (Johnson et al., 2007; PIRLS, 2007). A study of 15-year-old students in 31 countries concluded that

those using computers at school several times a week performed "sizeably and statistically significantly worse" in both maths and reading than those who used them less often (Fuchs & Woessmann, 2004). Another study from Duke University in the U.S involving 150,000 students also found, ‘the introduction of home computer technology is associated with statistically significant and persistent negative impacts on student math and reading test scores’ (Vigdor and Ladd, 2010).

GREEN CURRICULUM

Woodland ecology, gardening, horticulture and farming - while educational subjects in their own right - are increasingly found to positively affect cognitive functioning, academic performance, obesity and physical and mental health in young people. Mainstream science and medicine have taken an interest in a variety of unexpected effects linked to exposing young people to greenery and involving them in ecology, gardening, horticulture and farming. The academic fields of environmental medicine and ecopsychology have overlapped with preventative medicine to produce fascinating studies.

A growing body of evidence is now linking contact with nature with significant physical, mental, behavioural and intellectual benefits. The University of California’s division of Agricultural and Natural Resources concludes that contact with nature is “***contributing to positive youth and community development, promoting social development, and increasing academic performance, among other things***” (UCANR, 2007) Children also gain skills in a number of academic areas from regular experiences in a childhood program’s garden (Miller 2007).

A study entitled Children's Mental Health and Wellbeing and Hands-on Contact with Nature (Maller, 2006) concluded, ”Recent work on the health and wellbeing benefits of contact with animals and plants indicates the natural environment may have significant psychological and physiological effects on health and wellbeing of children. These studies demonstrate that children

function better cognitively and emotionally in green environments and have more creative play in green areas." The following is a brief range of positive effects:

- Children with symptoms of Attention Deficit Hyperactivity Disorder (ADHD) are better able to concentrate with a reduction in symptoms after contact with nature (Taylor et al. 2001; Taylor & Kuo 2011). The same is true of people *without* ADHD.

- Children with views of and contact with nature score higher on tests of concentration and self-discipline. The greener, the better the scores (Wells 2000, Taylor et al. 2001).

- Exposure to natural environments improves children's cognitive development by improving their awareness, reasoning and observational skills (Pyle 2002).

- Results for schools with outdoor education programs show better performance on standardised measures of academic achievement in reading, writing, math, science and social studies. Classroom behaviour showed improvements as well. (Lieberman & Hoody, 1998)

- Nature buffers the impact of life's stresses on children and helps them deal with adversity. The greater the amount of nature exposure, the greater the benefits (Wells & Evans 2003).

ADHD and Attention

But how can something as mundane as a tree or a flowerbed or grass exert any biological and cognitive effects on young students? One main area of interest is the effect of nature on one's ability to pay **sustained attention**.

Some scientists now report that modern activities and situations involving prolonged or intense use of our attention cause an attentional 'fatigue' to set

in. Interestingly a study in the American Journal of Public Health reports that in modern societies '...it becomes increasingly difficult to pay attention and inhibit impulses; that is, the behavior and performance of individuals without ADHD temporarily take on many of the characteristic patterns of ADHD'. (Kuo and Taylor, 2004)

The American Journal of Public Health Study has found that exposing children with ADHD to outdoor greenery significantly reduces their symptoms. The scientists evaluated the effects of 49 after-school or weekend activities conducted in green outdoor settings versus those conducted in both built outdoor and indoor settings. The results were highly impressive. And the effect was consistent across age, gender, socioeconomic status, and type of community, geographic region and diagnosis. In fact, the greener the setting, the greater the relief from symptoms. The researchers also pointed to 'substantial research conducted' among people ***without*** ADHD showing that inattention and impulsivity are reduced after exposure to green natural views and settings (Taylor, et al 2001). Similar findings continue to appear a decade later. Taylor and Kuo (2011) recently examined whether routine exposures to greenspace, experienced through children's everyday play settings, might yield ongoing reductions in ADHD symptoms. The answer appears to be yes: 'everyday play settings make a difference in overall symptom severity in children with ADHD. Specifically, children with ADHD who play regularly in green play settings have milder symptoms than children who play in built outdoor and indoor settings. This is true for all income groups and for both boys and girls.'

So, a growing number of researchers now believe that, for most of us, being exposed to greenery has general, widespread benefits for our ability to pay attention. Studies now report 'superior attentional functioning' and that 'the effect of nature on inattention is robust'. (Taylor, et al 2001; Taylor & Kuo 2011)

The explanations seem to revolve around the way greenery effortlessly engages one's attention, allowing one to attend without paying attention. The information-processing demands of everyday life including electronic media, mobile telephones, increasing consumer and 'lifestyle choices' and associated decisions – take their toll on young people's intellectual and emotional resources. They increasingly pay attention to more than one thing at a time – 'multitasking' – and are encouraged to do so. This modern life causes a temporary 'attention fatigue' which is corrected when our underlying attention system has an opportunity to rest. And natural green environments help in recovery from this attention fatigue, in part because they engage our mind effortlessly. So the sense of rejuvenation we often experience after spending time in natural settings may in part reflect a 'recharging' of some parts of our attentional system. This is the basis of Attentional Restoration Theory (Kaplan, 1995) suggesting that the natural environment disengages attention - nature offers 'soft fascination' - holding one's attention but leaving ample opportunity to think about other things.

While there may be clinical benefits of attentional restoration in cases of ADHD the effects of exposure to nature apply to young people in general in a wide variety of ways. For example, self-discipline requires a child's attention. So when their attentional system becomes tired their self-discipline declines, but when their attention is revived by exposure to greenery, their **self-discipline improves** again (Taylor et al. 2001).

The attentional benefits of contact with nature interact and overlap with other factors. A study of 120,000 children found benefits to children's **self-esteem and a reduction in levels of stress** experienced (Waliczek et al., 2000) In addition to the attentional restoration that may have been derived, through watching the development of their plant, children learn caring, responsibility and the ability to **defer gratification** by thinking in the longer term. Gardening enables you to focus on one thing – a live plant –and to gain a sense of control and completion by doing one thing well – planting and caring for it.

Clinical And Therapeutic Effects

Stress is now a significant factor influencing health and life span. And spending time amongst greenery is now associated with reduced stress. A recent study entitled “A Garden at Your Doorstep May Reduce Stress” looks at the stress-reducing effects of greenery in nine Swedish cities. The researchers conclude “having access to a garden has a significant positive impact on stress.” The study even measures the amount of ‘greenness’ people are exposed to by creating a “Home Greenery Index” and concludes “the more greenery there is (Home Greenery Index), the more positive the effect on stress.” How frequently people visit their own, or public gardens was also measured and they find “There is a significant positive relationship between frequency of garden visits and stress prevention.” (Stigsdotter & Grahn, 2004a,b) Another new Swedish study “A Garden at your Workplace May Reduce Stress” comes to similar conclusions. (Stigsdotter & Grahn 2003) These effects are probably evolutionary and hardwired into our nervous systems.

Exposure to nature and the countryside is becoming a serious approach to preventing and treating both mental and physical illness. Medical journals are now reporting: “*Evidence demonstrates that contact with nature enhances human health and well-being. … to protect and enhance the health of individuals experiencing chronic mental, emotional and physical health difficulties. CONCLUSIONS: 'Contact with nature' constitutes a health promotion strategy with potential application in prevention, early intervention, treatment and care.” (Pryor et al., 2006). “Nature plays a vital role in human health and well-being, …* ***contact with nature may provide an effective population-wide strategy in prevention of mental ill health****, with potential application for sub-populations, communities and individuals at higher risk of ill health. …To maximize use of ‘contact with nature’ in the health promotion of populations.*” (Maller et al., 2006)

Even one's **lifespan** is now being **linked to having access to green spaces**. A study published by the British Medical Association finds that people in cities live longer, healthier lives if they have easy access to "walkable green spaces". Furthermore, no matter what a person's social or economic status, 50% of the factors that will determine how long they live are associated with having ready access to greenery. (Takano T, et al 2002)

An hour of gardening a day is linked to a **reduced the risk of dying prematurely** by 28 per cent and may help reduce coronary heart disease and other chronic illnesses. Even 30 minutes of gardening a day on most days of the week that doesn't produce a noticeable improvement in physical fitness may offer **protection from certain chronic diseases**. (Kushi et al 1997, American heart Association, 2005)

'Wilderness Therapy'

Simply looking at plant life has even been associated with an improvement in a variety of medical conditions from clinical anxiety to addiction recovery. (Bennett et al., 1998). In fact the development of 'wilderness therapy' was the result these observations and is now used to treat people ranging from cancer and renal patients to the bereaved, helping them to cope more effectively with their situation. (Warady, 1994).

Generosity and Compassion

Given the evidence above that that there appears to be a genuine decline in levels of empathy accompanied by a rise in levels of narcissism amongst a new generation of young people, the findings of the study '*Can Nature Make Us More Caring? Effects of Immersion in Nature on Intrinsic Aspirations and Generosity'* are directly relevant to the woodland ecology, gardening, horticulture and farming components of integrated practical skills therapeutic education. Four studies conducted by the University of Rochester examined the effects of nature on prosocial and other values focussing on concern for other people, generosity, and self-focused value orientations. Young people 'immersed in natural environments' were judged as exuding values focusing

on concern for others with greater generosity, compared to those immersed in 'non-natural environments'.
(Weinstein et al 2009)

All of the effects found to be associated with contact with nature may be part of a larger phenomenon. **In the way that the RMET practical skills-based curriculum provides a 3-D education, which seems to satisfy an evolutionary imperative to involve hands in learning, that in turn stimulates brain and cognitive functioning, the incorporation of nature-based activities in the RMET curriculum seems to satisfy another evolutionary imperative.** Cross- cultural observations find that humans gravitate toward greenery. This inclination seems to be hard-wired into our psyche, the result of natural selection. Those who sought green areas or lived as subsistence hunters, gatherers and farmers were more likely to eat, drink and survive. Our evolutionary psychology is still strongly shaped by this ancient basic reliance upon and relationship with nature's plants. It seems that many of the benefits associated with our exposure to greenery are part of an evolutionary reward system reinforcing the very thing that kept us alive for hundreds of thousands of years. (Ulrich, 1993)

Agricultural Literacy

As attention focuses on the importance of food, nutrition and obesity for young people in Britain, one particular area of interest is the relationship between the degree of contact they have with the countryside and their 'agricultural literacy' – their awareness and understanding of the food chain.

To increase young people's agricultural literacy, the American authorities instituted the Vocational Education Act of 1963. Later, the prestigious National Research Council and National Academy of Sciences appointed a committee to assess the level of understanding American children had about agriculture which concluded, "The committee found a number of disturbing trends. Most Americans know very little about agriculture … particularly its links to human

health and environmental quality. Few systematic educational efforts are made to develop agricultural literacy in students of any age … knowledge of nutrition to make informed personal choices about diet and health." The committee developed the concept of "agricultural literacy – the goal of education about agriculture." (National Research Council, 1988)

Other more recent assessments of children's agricultural literacy since The Vocational Education Act of 1963 have reported "even more significant changes have occurred removing the average citizen even further from the farm… it could be argued that instruction related to an understanding of the critical importance of agriculture, food, and food production is just as 'basic' as reading writing and arithmetic … pre-secondary Agricultural Education should be designed to enhance student understanding of the role of agriculture in our lives." (WRC Committee for Agricultural Literacy, 1999)

Familiarity Breeds Literacy

The degree of contact pupils have with the agriculture translates into a better understanding and awareness of the food chain. Furthermore, pupils with greater agricultural literacy are more likely to make better food choices.

In other words, experience of where their food starts out is a vital ingredient in the battle to excite and engage students about their diets. It's also been established that the 'visual reinforcement' of actually seeing food growing outdoors significantly improves pupils' nutritional knowledge (by 22%), with that knowledge remaining even 6 months later.

However – even more importantly gardening and horticulture in a curriculum helps encourage a taste for the produce itself. In this study, real contact with food growing outdoors also helped to influence pupils' positive food preferences for:

- Broccoli (+20%)
- Snow peas (+ 31%)
- Courgette (+30%)
- Carrots (+9%),

Interestingly the pupils in this study even showed new “preferences for vegetables to which they were not directly exposed.” (Morris et al, 2002b) This indicates that exposure to outdoor agriculture has a general improvement effect on student's food choices. This backs up an increasing number of studies of school gardens, which have been shown to increase agricultural literacy, knowledge of the food chain, and may also improve dietary choices in pupils.

And studies of pupils from Tasmania to Tennessee indicate that real-life contact with agriculture makes the abstract more concrete **– pupils are more likely to absorb and integrate food knowledge if they have hands-on experience of its origins.** With this in mind there has been a growth in school gardens and allotments. An increasing number of **studies are finding that experience of school gardens increases agricultural literacy, knowledge of the food chain, and may also improve dietary choices in pupils.** (Morris, et al.,2000; Morris, et al. 2002a,b; O’Brien et al, 2006; Lineberger et al. 2000; Somerset, 2005)

The University of California’s division of Agricultural and Natural Resources is continuing to assess the effects of hands–on experience of agriculture for children. They recently reported that this approach holds “***great potential for academic and social development for youth. Research has proven that [it] provides a vehicle for improving nutrition, reducing obesity*** *… There is a strong feeling in that we need to forge a stronger connection between our children and the earth that feeds them. We will protect and preserve what we love, and we only love things we know*. (UCANR, 2007)

Videophilia

The most notable change in a child’s everyday life over the past decade has been the profound decline in their contact with the countryside. This phenomenon is apparent in Western industrialised countries.

A 16-year study recently found that Americans are less interested in spending time in natural surroundings … because they are spending more time watching television, playing video games and surfing the Internet. After a 50-year steady increase in visits to the countryside, a significant decline started as of 1988 “coincident with the rise in electronic entertainment media...”

Researchers tested more than two dozen possible explanations for the trend and found that 98 percent of the drop in countryside visits was explained by video games, movie rentals, going out to movies, Internet use and rising fuel prices. Other possible explanations such as family income or the aging population were ruled out. They identified “a fundamental shift away from an appreciation of nature –‘biophilia’ – to ‘videophilia’, the new human tendency to focus on sedentary activities involving electronic media.” (Pergams & Zaradic, 2006, 2008).

There is a similar phenomenon occurring in Britain. The Department for Environment, Food and Rural Affairs reported that between 2000 and 2005 the number of visits to the English countryside with at least one night’s stay has fallen by 38%, while the number of day trips to the countryside has fallen by 14 % since 1996. (Defra, 2006)

The RMET curriculum directly redresses the growing concerns about the lack of time humans, particularly children, spend in outdoor environments (Kellert, 2002; Orr, 2002; Pyle; 2002), the limited opportunities to encounter and interact with the natural world (Orr; 2002; Frumkin, 2001), and the fact that modern society insulates people from outdoor environmental stimuli. For children, concerns focus on the detrimental effects on cognitive and emotional development (Kellert, 2002), the paucity of opportunities to develop an ethic of care for the environment and empathy for other living creatures/fellow humans (Kahn and Kellert 2002), a lack of understanding about the interconnectedness of all life forms, as well as other valuable lessons to be learned from nature (Orr, 2002).

STORYTELLING

" *On specific [RMET] courses, such as story telling … learners develop social skills and self-confidence*." (Ofsted, 2007)

Storytelling is not thought of as a 'heavyweight' academic activity. However cognitive and neuroscientists are revisiting this 'folksy' tradition and reinforcing what school inspectors are noting.

Storytelling involves considerable cognitive demands: imagery, thinking ahead with plot and narrative, vocalisation, performance, listening and interpreting. For example, when the brain imagines it increases activity literally forming new dendrites and synaptic connections. Imagery therefore speeds communication within the cells and between the cells in the brain. Imagery building skills from oral word 'paintings' involves a process of conscious thought that transfers to reading imagery skills. If you visualize what you hear, you facilitate the ability to visualize what you read." Storytelling, probably the oldest form of narrative in the world, is not the same as reading aloud, because in storytelling, the interaction between teller and listener is immediate, personal, active, and direct. (ERIC, 1988)

Like other components of the RMET curriculum, storytelling was a necessary evolutionary survival mechanism, built into the fabric of the brain and if it's not our own story we are attending to we readily latch on to others. The neuroscientist Michael Gazzaniga (2005) locates the storytelling 'machinery' in the brain's left hemisphere: the function of "the Interpreter", as he calls it, is to identify patterns of connection between different brain modules and correlate them with events in the external world. The activity, internal and external, is wound into a single narrative thread of subjective experience. This is why **storytelling provides excellent cognitive exercise - in neurological terms it is a cognitive multi-gym.**

One example of how storytelling may have unexpected effects on neuro-cognitive functioning is seen in a Canadian study. Helping children to develop

their storytelling abilities was linked to their success in maths years later. This is a good example of how a the brain often benefits from one form of stimulation, later enhancing skills you would normally assume come from a completely different form of stimulation. O'Neill et al., 2004)

Brain development and maintenance is dependent upon induced imagery. That is, in order for the brain to develop properly and to be maintained throughout life, it must be stimulated; instead of "use it or lose it," it's "use it or never get it to begin with." Induced imagery means creating pictures in the mind. Most children today are exposed mainly to imposed imagery: television, DVDs, computer-based images, and even picture books. The brain's function is reduced to taking in something that is already in front of the eye, rather than creating an image of something that is not apparent. Research has found that **storytelling, or reading aloud a chapter book without pictures, is an exceedingly effective method of stimulating the brain's ability for induced imagery**. (Muller, 2000) Perhaps parents have known all of this intuitively which is why they read stories to their children.

During the 1970s and 1980s, Roger G. Schank, former head of the Artificial Intelligence Laboratory at Yale University, was examining the issue of how we think, and how our thinking processes influence our behaviour. He was attempting to develop artificial intelligence programs for computers through this work. What he found was that the human brain is programmed to think in terms of stories. A human brain may receive thousands of pieces of information daily. Most of it we can't retrieve, even minutes later, while other information can stay with us for years, and we can easily recall it. Why? Because the information that we tend to remember is presented in the context of a story about the information, person, or event. In Schank's book *Tell Me a Story: A New Look at Real and Artificial Memory*, he states, "Stories give life to past experiences; stories make events in memory memorable to others and to ourselves." In other words, memories are really stories, which can be recalled at a later time. Pupils who are exposed to information in the context of a story can better recall it later. (Schank, 1990)

Storytelling provides imagery-building skills, creates an attentive listener, expands interest into new areas, centres the attention of the class, and teaches language, story plots, folkways, ethics, traditions and customs. Storytelling can supplement and enhance the existing literacy program by supporting teacher's language arts programs. "Stories are effective alternative methods of teaching cross cultural, understanding, family and community values, writing, and speaking skills. The oral story as a traditional transmitter of folkways, ethics, traditions, and customs is an effective provider of information that impacts on behaviour modification. The entertainment quality of the oral story provides not only a mechanism to transmit information to an attentive listener but also has the residual effect of improving reading motivation. Storytelling conveys language and story plot structure, which enhances reading comprehension. "Poor readers of every age have difficulty connecting between what they read and what they already know. Telling a story provides a road map of information, ideas and characters to the listener and when coupled with a discussion of the story, the student learns that the purpose of reading is to acquire information and insight." **The oral story holds the attention of the listener and this process of focusing a group's attention spills over into other educational activities enhancing social skills and confidence.** (US Dept Education, 1988;ERIC, 1988; NCTE, 2008)

Is There Still an Opportunity to 'Improve' 16-25yr olds?

Can earlier deprivations or difficulties be redressed during a three-year period of education in teenagers and young adults? "Until recently, general cognitive capacities were seen as relatively fixed and not subject to change, at least in nonclinical populations. However, this picture is changing." (Ybarra et al, 2008).

Part of the answer concerns the process of brain development and how experiences influence the size, structure and function of the young adult brain – literally - irrespective of learning difficulties. Young adult brains don't even

finish growing in size until the mid to late twenties and so there is opportunity to influence that development through practical skills therapeutic educational experiences.

One example referred to earlier on involved the effects of greenery significantly reducing the symptoms of ADHD or improving the ability to pay attention for those who do not have ADHD (Taylor et al, 2001; Kuo and Taylor, 2004; Stark, 2003; Taylor & Kuo 2011)

Understanding how the brain learns reveals why some shortcomings can be redressed or at least improved upon. The types and degrees of stimulation the student receives from his environment affect the actual number and the density of his brain cell connections, and width of blood vessels, which supply the brain. This process of moulding, referred to as *structural neuroplasticity*, affects both the brain structure and function and appears to influence brain cell development and the regulation of the brain's chemical messengers (neurotransmitters). **Cognitive demands physically improve and enlarge children's brains.**

Using your brain actually increases the number of dendritic branches that interconnect brain cells. The more we think, the better our brains function – **regardless of age**. The neurobiologist Marian C. Diamond, professor at University of California at Berkeley has conducted a great deal of work in this area (Diamond et al, 2001) and concludes, "The nervous system possesses not just a 'morning' of plasticity, but an 'afternoon' and an 'evening' as well."

Diamond found that **whether we are young or old, we can continue to learn**. And while the greatest opportunities lie with the young, the brain can change at any age. A dendrite grows much like a tree – from trunk to limbs to branches to twigs – in an array of ever-finer complexity. In fact, **older brains may have certain advantages**. She discovered that more highly developed neurons respond even better to intellectual enrichment than less developed ones do. The greatest increase in dendritic length occurred in the outermost dendritic branches, as a reaction to new information.

Far beyond the college age group of pupils, a study published in the *Journal of the American Medical Association* found that **significant intellectual gains can be made in people over 65**. In the trial, 2800 adults aged 65 and over each received only 10 hours of cognitive training (e.g. reasoning, memory and speed-of-processing) over the course of only five weeks. Five years later, these older 'pupils' showed significant gains across the board. (Willis et al, 2006)

An example of how pupils of 16-25 could improve certain cognitive abilities is seen in the finding that learning to meditate as an adult actually **increases the thickness of the brain's cortex in areas involved in attention and sensory processing**. (Lazar et al., 2005) New studies find that even physical leisure activities like golf that are merely mentally rehearsed in the minds of middle-aged adults induce beneficial changes in 'functional neuroplasticity' within their brains (Bezzola et al 2012).

The Apprenticeship-Tutor Relationship

Beyond the business of imparting practical skills, the second process of the apprenticeship-tutor relationship is the inadvertent, sometimes incidental, lesson in how to be an adult - in particular, how to be a man - how to behave, interact, respect elders or those of experience, those in authority. Apprenticeships provide an arena for becoming socially viable. The intensive mentoring that occurs at the Ruskin Mill colleges, in addition to cultivating capacity building and imparting general transferable competencies, may act to develop and enhance the process of maturation and stability in young people. And this in turn may benefit the student but also the employer, who will end up with an employee who is "higher quality" and are "more loyal … motivated and satisfied " because they are more viable human being who also learned saleable skills.

SOCIAL AND EMOTIONAL VIABILITY

For education to reach fruition in adulthood it must help students to develop into socially and emotionally viable human beings. It has been often said that there is an inherent lawfulness imparted through learning crafts. Therefore, such a curriculum is also a socialising process – life learning through doing. And so, the social and emotional landscape of a college is the second, and interesting chapter in the story of how a practical skills therapeutic curriculum exerts its fullest effects.

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