PRACTICALLY MINDED

The Benefits and Mechanisms Associated with a Craft - Based Curriculum

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Commissioned by the Ruskin Mill Educational Trust (RMET)

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While the effects of a practical curriculum have been valued and noted (LSC, 2008; Ofsted, 2007), 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 craft-orientated 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 findings 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 craft 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'.

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 intellectual development.

Cognitive and Neurological Development

- Using tools such as those in craft activities, uses and strengthens "*widely distributed, yet highly interactive, [brain cell] networks"* that go far beyond the skills, hand-eye and muscle coordination related to the craft. This tool use - described as *"complex, real-world behavior*" – also involves and stimulates "*social, cognitive, perceptual and motor processes*."

- 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.

- '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.

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

Locus of Control

- The mechanism by which craft 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 craft-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.

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 factors involved in such 'an holistic approach' are the subject of a further report in progress.

THE WHOLE IS GREATER THAN THE SUM OF ITS CURRICULUM

"***The [RMET] curriculum …is primarily based on craft activities where the learner is fully involved in all stages of the process, from raw material to finished product.***" (Ofsted, 2007)

Within that sentence lie several fundamental factors that are increasingly found to potentiate cognitive, social, emotional and intellectual 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 and craft-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)

The LSC has been actively promoting the benefits of learning skills through the campaign "*Our future. It's in our hands' - the LSC's most ambitious communications campaign ever and aims to inspire people across England to take control of their future through learning and play an active role in achieving their full potential*."

The LSC draws attention to the fact that many young people prefer to "do something real and practical".

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 (Press, 2008).

Moreover, the LSC is also emphasizing the role of *apprenticeships* in learning skills. "The effect of apprenticeships cannot be over-estimated as a key factor in cultivating capacity building and general transferable competencies in young people." (LSC, 2008) (This will be the subject of a further report by this author, Aric Sigman)

Research in the manufacturing industries has 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 get 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 practically oriented curricula which as described in a recent 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, dis-empowers 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 craft-based curriculum 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 curriculum has wider benefits than were previously expected.

3-D EDUCATION

A curriculum primarily based on craft 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, 2007a,b; 2008)

"Over the course of childhood, children spend more time watching TV than they do in school." (Zimmerman, 2007). Twenty Five per cent of British 5 year-olds own a computer or laptop of their own. (Childwise Monitor, 2008). British children aged 11 to 15 now spend 55 percent of their waking lives - 53 hours a week, seven and a half hours a day – watching TV and computers, an increase of 40 per cent in a decade. (BMRB, 2004). Television is displacing the parental role, eclipsing "by a factor of five or ten the time parents spend actively engaging with children".
Children's Society (2008)

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. 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).

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.

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 just 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 in crafts appears to 'exercise' the brain in a variety of ways that go far beyond the capacities used for the specific task at hand.

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

Another way to consider the benefits of craft activities is by looking at the primal and central role of hands in learning and creation. 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).** This hand-to-brain relationship is so strong that the American Academy of Neurology has just reported that hand stimulation can be used to therapeutically improve brain function in adults (Rosenkranz et al, 2008).

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)

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)

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 craft 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 RMET curriculum involves precisely these visible and concrete displays of success.

SUSTAINED ATTENTION

Sustained attention and **self-regulation** are cultivated and reinforced through a craft-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)

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)

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).

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 after contact with nature (Taylor et al. 2001). 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).

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. 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)

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 **can reduce the risk of dying prematurely** by 28 per cent and 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 will offer **protection from certain chronic diseases**. (Kushi et al 1997, American heart Association, 2005)

'Wilderness Therapy'

Simply looking at plant life has even been found to improve 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).

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 craft-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 <u>hands-on experience</u> 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).

There is a similar phenomenon occurring in Britain. The Department for Environment, Food and Rural Affairs has 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) Parents, perhaps have known all of this intuitively which may explain 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.

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)

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)

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 curriculum exerts its fullest effects.

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