Edge There are many paths to success

Centre for Real-World Learning at the University of Winchester

Bodies of knowledge

How the learning sciences could transform practical and vocational education

Guy Claxton, Bill Lucas and Rob Webster

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Report written by Guy Claxton. Bill Lucas and Rob Webster
Centre for Real World Learning at The University of Winchester
www.winchester.ac.uk/realworldlearning

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Foreword

Practical and vocational learning is no less intelligent than academic learning and every bit as worthy of our full admiration. That's something that both Edge and a growing number of educational institutions believe. Indeed, Edge's whole purpose is to celebrate, support and promote practical and vocational knowledge and skills wherever and whenever they arise. Edge believes, very firmly, that there are many paths to success. And at last we have powerful research evidence from the Centre for Real World Learning which significantly helps to advance these arguments.

'Bodies of Knowledge' challenges the centuries-old assumption that mind and body are somehow separate, and that 'mind' is superior to 'body'. The authors have drawn on research in the fields of cognitive science and neuroscience to demonstrate that the mind and body work together to develop knowledge, understanding and skill. This is as true for the professor who walks and gestures while thinking and talking, as for the hairdresser who uses touch to shape ideas about the best way to cut and style a head of hair.

The science of 'embodied cognition' is an emerging area of research, but it builds on ideas developed and implemented over a great many years. As far back as 1907, Maria Montessori realised that young children learn through experiment and experience. More recent research shows that what is obviously appropriate for a four-year-old may well be of much greater relevance to a 17-year-old (or a 50-year-old) than we had previously thought.

Furthermore, there are many forms of intelligence, and many intricately interwoven elements to intelligence. This provides the basis for the authors' new framework for learning, comprising presence of mind – put simply, the moment in which someone is open to learning – four habits of mind and six frames of mind.

We draw on these habits and frames of mind, in varying degrees, whenever we learn *about* something, or *how to do* something. There is essentially no difference in the habits of mind, nor the frames of mind, of someone who is learning about literature, and someone who is learning how to repair a refrigerator. Both of them investigate, experiment, reason and imagine. Along the way, they show curiosity, determination, resourcefulness, and so on. In the authors' words, 'the kinds of investigating, experimenting, imagining and reasoning that go on in a repair shop or a retail outlet are as rich, interesting and appropriate as those that go on in a university seminar.'

This is incredibly important. Once we use the same language to describe all forms of learning, we see how false it is to distinguish between 'academic' and 'practical' learning: just as false as the idea that the mind and body are separate.

The new language of learning also opens up new ways of looking at how we teach, and how we help people to learn. Education – whatever its form, and however it is described – has to help students to develop knowledge and apply it to a particular context. People who teach – whether in the classroom, the laboratory or the workplace – should both capitalise on, and develop, the habits and frames of mind outlined here.

But this is only a start. The authors set out a challenging list of questions. How can explicit thinking be cultivated so that it becomes a habitual tool for lifelong learning, and not just a tool for passing exams? How can we harness (or in some cases, revive) young adults' natural curiosity? How can we build up students' confidence to ask questions, collaborate effectively, and ask for help and advice when they need it?

'Bodies of Knowledge' raises the stakes. If we can agree a common language to describe the processes of learning, we can – at last – appreciate the way people blend knowledge, ideas and practice to become experts in their respective fields, free from the artificial assumption that some forms of learning, and some types of talent, are inherently 'better' than others. From there, we can find better ways to foster the habits and frames of mind which, when combined with presence of mind, turn us all into successful learners.

Andy Powell, Chief Executive, Edge Foundation
Professor Joy Carter, Vice Chancellor,
University of Winchester

Executive summary

This is the second of two reports for Edge. In our first, *Mind the Gap; Research and Reality in Practical and Vocational Education,* we reviewed the current state of Practical and Vocational Education (PVE) in the UK, explored some international comparisons and considered the degree to which it is possible to measure PVE's impact. We made a number of recommendations as to how the practices of PVE could be improved and how more helpful means of evaluating its impact could be developed.

The new learning sciences

In this second report we explore the ways in which the sciences of learning can contribute to raising the esteem of PVE. The science is developing apace, but its implications for PVE have not previously been explored in detail. That's what we aim to do here.

We begin by demonstrating some of the ways in which the science of embodied cognition is helping us to understand how mind and body work together. We show that, far from being 'inferior', practical activity can be at least as complex, demanding and satisfying as 'academic' learning. As we outline some of the new thinking associated with embodied cognition we are able to use scientific research to debunk many of the myths associated with practical learning.

A working model of real-world learning

Drawing from a broad range of research from a predominantly constructivist perspective, we offer a model for PVL (or as we term it 'real-world learning'). Our model offers a combination of habits and frames of mind characteristic of successful learners in a wide range of spheres. We also stress the importance of the context of learning both from the perspective of the learner in the moment of engagement (we call this 'presence of mind') and in terms of the cultures and contexts in which learners find themselves.

The habits of mind we explore are:

- Investigating
- Experimenting
- Reasoning and
- Imagining.

By exploring these four habits of mind in more detail we seek to show the ways in which the pedagogies and practices of PVE might be further developed.

We focus on these frames of mind:

- Curiosity
- Determination
- Resourcefulness
- Sociability
- Reflection, and
- Wisdom.

These six frames of mind suggest a number of fruitful questions which PVE practitioners may wish to consider. Most essentially, the evidence suggests that each of these qualities of mind can be either suppressed or developed by the context of learning, and raises the possibility that PVE could – and, we argue, should – aim to strengthen these, as well as developing vocationally specific knowledge, skills and attitudes.

Although firmly rooted in research, our model is novel and, in places, speculative. Nevertheless we believe it helps us to see that practical and vocational learning is no less intelligent than academic learning and every bit as worthy of our full admiration. For each of its elements we suggest practical lines of enquiry which we believe those interested in PVE might fruitfully pursue.

Learning contexts

PVL rarely takes place entirely in isolation. In almost every aspect of PVE there will be 'communities of practice' from which the learner can draw strength. And increasingly we are finding out more about which aspects of organisational cultures are hospitable and which can be unhelpful to the development of learners. Thus far, we suggest, not enough attention has been paid to the social context of the workplaces in which vocational learning is nurtured. We make suggestions about how research might improve the transfer of learning from classroom or workshop to workplace and home.

An exciting future

The new thinking which we review and the working model we offer present exciting opportunities for a reappraisal of the way we do PVE in the UK (and elsewhere). For alongside the more obvious domain-specific curriculum with which educators are familiar we are in essence presenting a parallel world of PVL processes. We believe that these two approaches are two sides of the same coin. From the habits and frames of mind we describe spring confidence, pride and creativity as well as enhanced competence in whatever area of PVE is being learned.

Preface
Setting the scene

It is increasingly evident that the educational methods we have been using for the past 70 years no longer suffice. They are based on scientific assumptions about …the learning process that have been eclipsed by new discoveries. Yet changing them has been slow because the nature of educational reform is largely one of tinkering with institutional arrangements. Rarely has reform penetrated the 'educational core'.
Professor Lauren Resnick[1]

In our first report, *Mind the Gap*[2], we reviewed the current state of Practical and Vocational Education (PVE), drawing on research from across the world. In addition to mapping current practice in the UK and learning lessons from other countries we concluded that lack of sufficiently rich data about the experiences and biographies of those engaged in Practical and Vocational Learning (PVL) is seriously hampering us in understanding the impact of PVE on individuals and on society. Given the lack of existing impact data we tentatively suggested an approach to the collection of the kind of data that might be useful. We also sought to describe those learning methods and pedagogies which seem most effective in supporting PVL, along with an indicative set of useful assessment methods.

In this second report, *Bodies of Knowledge; How the Learning Sciences*[3] *could transform Practical and Vocational Education*, we focus on the scientific basis of PVL. As the above quote from Lauren Resnick, one of the most eminent of education researchers in the USA, suggests, our understanding of the process of learning has come on in leaps and bounds in the last few years – yet education has been slow to explore and implement some of the possibilities which that science has brought to light. In *Bodies of Knowledge*, we review aspects of this research which we think bear most directly on the development of PVE. In particular we argue that the emerging science of embodied cognition is offering exciting new thinking about what is going on when brain and body are working together. We explore this research in sufficient detail to be able to make a strong case that one of the reasons practical (and much vocational) learning is so undervalued is because of a fundamental lack of understanding about how intricate and intelligent it actually is.

We then go on to offer a research-based model of practical learning that attempts to do justice to this intricacy. Adopting constructivist[4] approaches to teaching and learning, our working model explores the habits and frames of mind required by effective learners. Drawing on a range of disciplines within what is now referred to as the learning sciences, we illustrate the research that underpins the different elements of the model. In addition to drawing on material already generated for our first report, we have specifically reviewed a wide range of literature from the learning sciences both within the realm of PVE/PVL and more broadly. Some of the science involved is still quite new, and in some cases contested, so our model is inevitably conjectural. Nevertheless, we think it is robust enough to suggest fruitful lines of enquiry about how to make PVE more engaging and effective especially for young adult learners.

Finally we explore the wider cultures and contexts of PVE and seek more specifically to apply our thinking to the PVE system. Having spent much time focusing on the skills and attitudes of the effective learner, we end by using our model of real-world learning as a means of thinking through the social implications of the PVE system.

1. Lauren Resnick (1999), Making America smarter, *Education Week Century Series*, 18(40), pp. 38–40.
2. Bill Lucas, Guy Claxton & Rob Webster (2010) *Mind the Gap,* London: Edge
3. The learning sciences are an emerging field of often interdisciplinary areas including, among others, cognitive psychology, educational psychology, anthropology and, increasingly, neuroscience
4. Constructivism is a theory of knowledge founded on the belief that human brains are not tape-recorders, but actively generate knowledge from their experiences. We explore this position in more detail in chapter 3.

Chapter 1
Let's get physical

The hand is the cutting edge of the mind
Jacob Bronowski[1]

There appears to be a widespread resurgence of interest in practical learning. In the USA, the 'Maker Movement' is pressurising manufacturers to make their machines more mendable. There are Summer Schools in Tinkering[2] for young people, in which they learn practical skills, and are often scraped and bruised in the process. Stanford University now gets its student designers and architects to build model airplanes and take bicycles to bits, while MIT runs a course called 'How to Make (Almost) Anything' that is one of the most popular on campus. In the UK *The Dangerous Book for Boys*[3] was the runaway best-seller of 2006 and has spawned a number of lookalike books promoting challenging, practical activities for boy and girls.

In times of recession, interestingly, sales of art materials to the general public go up markedly, signalling a renewal of interest in cheaper, hands-on forms of manual accomplishment and satisfaction. Governments rue the extent to which manufacturing industry – the business of actually making things – has been allowed to run down, and to be replaced by the precarious abstract worlds of banking and 'financial services'. And books such as Richard Sennett's *The Craftsman*[4] and Matthew Crawford's *Shop Class as Soulcraft*[5] argue that the current public rhetoric of 'skills' woefully fails to do justice to the sustained love-affair of the jeweller, gardener, animator or architect with their materials and capabilities. 'Being a cook' is not just a matter of skill, Sennett reminds us; it involves passion, identity, sensitivity, creativity and community as well. Anyone who saw the television documentary in which celebrity chef Jamie Oliver trained fifteen novice chefs to operate in a commercial restaurant would have seen this assertion translated into a compelling narrative[6].

In short there is rebellion in the air from various quarters against the reduction of young people's bodies to the 'Listen-Read' and 'Talk-Write' processes of classroom-based education and training, and the 'Eye-Brain-Finger' configuration demanded by the world of the computer screen. Crawford, for example, reminds us that there are many practical skills that can't be deployed over the internet. Someone in a call-centre in Bangalore may be able to help you install your new broadband package, but they can't unblock your sink, style your hair, fix your car or build your extension. The more powerful the digital world becomes, the more obvious it is just how many skilled and intelligent activities require a real, present physical body.

Such straws in the wind suggest a revival of interest, personal, social and economic, in the challenges, satisfactions and necessities of practical activity – learning that involves bodily activity, physical skill and tangible material – as a balance to the kinds of learning that mainly manifests itself as mouse-clicks and memos, key-strokes and spreadsheets. From windsurfing to ballroom dancing, plumbing to dress-making, farming to baking, 'making and doing' remain powerful sources of human learning and fulfilment at both work and play.

At the same time as this re-embodiment of learning, there are stirrings of interest from educationalists across the world in a complementary kind of practical learning: the wider skills and attitudes

'From windsurfing to ballroom dancing, plumbing to dress-making, farming to baking, "making and doing" remain powerful sources of human learning and fulfilment at both work and play'

1. Jacob Bronowski (1973) *The Ascent of Man*, London: BBC Books
2. See www.gevertulley.com where Gever Tulley, the founder of Tinkering School, has a lecture called 'Five dangerous things you should let your child do'
3. Conn Iggulden and Hal Iggulden (2006), *The Dangerous Book for Boys*, London: HarperCollins
4. Richard Sennett (2008) *The Craftsman*, London: Allen Lane
5. Matthew Crawford (2009) *Shop Class as Soulcraft: An Inquiry into the Value of Work*, New York: Penguin Press
6. See www.fifteen.net for more about this example and how it has spread to Cornwall, Amsterdam and Melbourne

young people are supposed to need if they are to survive and thrive in a fast-changing and increasingly complex world. If manual dexterity remains as important as mental agility, it is equally the case that certain attitudes and dispositions seem to contribute to people's ability to engage confidently with such complexity, and to learn how to handle it. Our review of such attitudes and skills for NESTA[7] (The National Endowment for Science, Technology and the Arts), for example, is part of an international re-appraisal of the role all education should be playing in supporting the development of these enabling qualities of mind. In the UK Edge[8], along with ASDAN[9] and the RSA[10] have led the way in championing the value of this kind of practical learning in schools and colleges. In this report, we are seeking to honour and integrate both these kinds of practical learning: the manual and the attitudinal.

Education's curious undervaluing of practical subjects

Yet, as we know only too well, societies place some strange judgements of value on practical accomplishments. Cellists, surgeons and architects are esteemed, while folk singers, occupational therapists and civil engineers get less recognition. The occasional celebrity chef, gardener, craftsman, vocalist or footballer serve only to emphasise the more lowly esteem in which cooking, gardening, car mechanics, singing and sports are held – especially within education. 'Abstract' is widely seen as more intelligent, more complex, and *better* than 'concrete'.

Today, for example, it remains an easy task to rank-order school subjects[11] from the most rarefied and disembodied at the top of the hierarchy of esteem to the most physical and material at the bottom. Mathematics carries most prestige, having apparently nothing of the body about it at all, and representing a Platonic world of pure geometrical forms, algebraic symbols and abstract computations. English is not far behind. There may be 'creative writing' now, but there are also abstract categories such as 'conjunctions' and 'participles' to be mastered, and the timeless treasury of Shakespeare to be understood. ICT is certainly useful (though arguably most young people learn what they need to know about it outside school), but its slightly lower status than pure maths seems to derive partly from the fact that it requires machinery, rather than just pen and paper. The sciences are esteemed in order of their proximity to maths – Physics, then Chemistry, and lastly Biology. Then come History, Geography, Modern Foreign Languages, Art and Music, and traditionally, at the bottom of the heap, those subjects from which the body most obviously cannot be excluded: Dance, Drama and PE, and Design and Technology – what used to be called Woodwork, Metalwork, Needlework and Cookery. These are also the subjects that are often scaled back or dropped altogether as pupils enter Key Stage 4 in order to meet the sometimes narrow assessment demands of GCSE. Vocationally-related qualifications, such as BTECs, have enjoyed even less esteem. Some of the latest innovations we reviewed in our first report, *Mind the Gap*[12], such as Diplomas and the more generic 'Functional Skills', also risk falling victim to this hierarchy of esteem.

Why is it, when many people can get so much satisfaction, and make good livings, from learning to do subtle things with their hands, feet and taste-buds, that schools and colleges persist – despite many determined efforts – in treating practical learning as second rate? In this report, we argue that this hierarchy of esteem reflects some deep but outmoded misconceptions about the nature of *bodies*, and their relation to *minds* and to *'intelligence'*. To esteem abstract rationality above practical virtuosity is to see Mind and Body not as intricate and equal partners, but as themselves hierarchically ordered. Before the advent of modern neuroscience, such a view might have been understandable. Now there is good reason to believe that this form of educational apartheid is both scientifically inaccurate and socially pernicious. Current research on the 'intelligence of bodies' needs to become more widely known, so these anachronistic beliefs and values can be reappraised and updated, and their negative effects on the self-respect of individuals, as well as the prosperity of their societies, can be removed.

Descartes' error

To begin to understand how this state of affairs came about, we need, quite literally, to peek inside the brain. The human brain is not much to look at. Slice the top off someone's head like a boiled egg and what you see is a three pound wrinkly blob of grey-brown spongy meat. If you put your ear to it, you hear no sounds. If you cut it open, you find no

'Thousands of young people who are good with their hands and feet, but not so good with equations and prepositions, have been led to think that their talents and interests are second-rate'

7. Bill Lucas and Guy Claxton (2009) *Wider skills for learning; what are they, how can they be cultivated, how could they be measured and why are they important for innovation?*, London: NESTA

8. See www.edge.co.uk for more about the range of current activities

9. According to the ASDAN website, ASDAN is established as a registered charity for *'The advancement of education, by providing opportunities for all learners to develop their personal and social attributes and levels of achievement through ASDAN awards and resources, and the relief of poverty, where poverty inhibits such opportunities for learners.'* See www.asdan.org.uk/what_we_do.php

10. For more about the RSA's Opening Minds competency-based curriculum, see www.thersa.org/projects/education/opening-minds

11. In terms of time allotted to their study or the range of choice to which qualifications in those subjects gives access, for example.

12. Bill Lucas, Guy Claxton & Rob Webster (2010) *Mind the Gap*, London: Edge

movie show going on inside. It is eternally dark and silent; and it looks rather unimpressive.

To anyone looking at a brain, before about a hundred years ago, it would have been literally unthinkable that this dull organ could be intelligent, in any real sense. Descartes was no fool: in the 16th century it would have been just plain obvious that consciousness, reason and imagination could not arise from the machinations of any kind of meat, let alone this particularly uninteresting-looking lump. Mind stuff was clearly different from body stuff. Minds were clever, conscious and sophisticated, capable of reason and decision-making. Mere flesh was mechanical, menial and, by contrast with minds, simple. The 'house-keeping' processes with which bodies concerned themselves – breathing, digesting, contracting muscles and so on – did not warrant being called 'intelligent'.And minds were also capable of 'knowing God'; they had the capacity for purity and sanctity, while bodies were corruptible and unreliable. So minds were not only much more complex and intelligent than bodies, they were also 'higher', while bodies were lustful, wayward and therefore 'lower'. (If bodies could be said to have 'knowledge' it was merely, and reprehensibly, of the carnal variety.) The schism was cognitive, moral – and unbridgeable. Descartes declared, for example: 'There is nothing included in the concept of the body that belongs to the mind; and nothing in that of the mind that belongs to the body'.[13]

This powerful attitude towards minds and bodies – 'Descartes' error', as neuroscientist Antonio Damasio has dubbed it – was born in classical Greece, strongly endorsed by the early Christian church, and turned into irrefutable 'common sense' by the learned philosophers of the Enlightenment, that period in our history when rationality was the highest manifestation of our humanity.[14] 'Mind over matter', and especially over the physical matter of which we are composed, became the watchword. This disparity of esteem between the physiological and the intellectual became enshrined in the core social institutions of the Western world. Christian religion revolves around a struggle between our baser bodily impulses and our 'higher nature'. God gave us reason and 'free will' so we could overcome the sinful dispositions of the body, and be bettered by the struggle. The law's attitude to crime hinges on whether the accused is judged to have 'been in his right mind' – and therefore had the capacity (but not the inclination) to override his antisocial impulse – at the critical moment. And so on.

Because Descartes had no way of understanding the cleverness of bodies and brains, thousands of young people who are good with their hands and feet, but not so good with equations and prepositions, have been led to think that their talents and interests are second-rate, demanding, perhaps, of hard work and practice, but not requiring genuine intelligence.

Whilst those deep-seated assumptions about both the *separation* of mind and body and the *primacy* of mind over body remain in place, attempts to generate 'parity of esteem' between so-called academic and practical learning are unlikely to succeed. For years, governments have tinkered with the structure, rhetoric and assessment of practical and vocational education. New Diplomas try to blur the disparity of esteem, and courses in practical subjects are bulked up with watered-down theory (like supermarket chickens) in order to try to raise the weight of esteem in which they are held. (It is no accident that some of the vocational courses that are most highly valued by practically-minded students and their employers are precisely the ones which do not pretend to be what they are not)[15].

But all of this phoney gravitas is often to no avail because the underlying assumptions about mind and body remain in place in the minds of politicians, educators, students themselves, their parents and the world at large. Indeed, the attempt to raise the esteem of practical learning by trying to make it look more 'academic' rests on the very premise that needs to be questioned – that the more scholarly-looking the subject, the better it will be for getting on in life.

But now cognitive science and neuroscience are threatening to turn these venerable assumptions on their head. Research shows that we think not just with our minds but with our brains and the rest of our bodies. In fact a new model of 'mind' is being created, one in which physical activity and practical learning have a key role. This new research is beginning to help us understand some of the things which have sat uncomfortably in our old body/mind split; why, for example, young learners do better in maths when they

'Research shows that we think not just with our minds but with our brains and the rest of our bodies'

13. Quoted in Fred Sommers (1978), Dualism in Descartes, in Michael Hooker (ed), *Descartes*, Baltimore: Johns Hopkins Press

14. Antonio Damasio (1995), *Descartes' Error*, New Cork: Quill. For the history, see Eric Robertson Dodds (1951), *The Greeks and the Irrational*, Berkeley: University of California Press; Guy Claxton (2007), *The Wayward Mind*, London: Little Brown

15. See Bill Lucas, Guy Claxton & Rob Webster (2010) *Mind the Gap,* London: Edge, in which we describe some successful courses of this nature in the UK, for example, ASDAN and the ever popular BTEC

use their hands, or why actors rely on movement and posture to help them learn their lines. The name of this exciting new hybrid research field is 'embodied cognition'.

Embodiment: the science of physical intelligence

When Friedrich Nietzsche quipped 'Never trust any thought you have while sitting down'[16] he was acknowledging the importance of the body in thinking, and thereby anticipating the science of embodied intelligence. The science of embodiment, or embodied c'gnition,'is an emerging area of research that demonstrates and illuminates the intimate relationship which exists between mind and body. It seeks to explain how the way we think depends on what we are doing with our bodies and how we are interacting with the physical environment. The eminent roboticist Rodney Brooks[17] argues that: 'The physical manifestation of the body is primary. The stuff of intelligence has evolved in conjunction with that body and is a *modulator* of its behaviour rather than a primary and central control system.'

Our body is not just our mind's container and perambulator; mind itself is one aspect of the whole bodily system. What do you do when you are struggling with a complicated problem? Do you sit quietly and close your eyes, doodle absent-mindedly, pace up and down, or go for a run? How we answer this question moves us into the territory of the embodied mind. For it is increasingly clear that the quality of our thinking differs according to what our body is doing at the time (and the relationship is different for different people). As we learn more about embodiment it seems that, far from language and mathematics occupying domains divorced from the physical, they actually have their origins and foundations in the way our bodies have evolved.[18]

To go into the full details of this area of research would take a whole book. But a mention of some recent developments and findings might serve to indicate the way this kind of science is moving.

1. Doing comes before seeing and thinking

The brain is designed to put 'doing' before 'seeing' or 'thinking'. We have evolved to be fundamentally active, not contemplative, creatures. The idea that human cognition proceeds in a linear sequence from Perceiving through Interpreting to Thinking, Deciding and then Acting is out of date. Before we open our eyes in the morning, our sensory systems are primed by what we *want* to do and what we are *able* to do, and the interaction between Wanting, Doing, Perceiving and Thinking is intricate, near-instantaneous (within hundredths of a second) and continual.[19]

The brain sees objects differently depending on whether they are near our hands or not (even when our hands are hidden from view) – because the proximity of our hands makes the brain look for clues about how graspable or manipulable the object might be.[20] The brain has a whole visual system for grasping that is not fooled by visual size illusions. Things can be made to *look* bigger than they are, but when we reach out to grab them, our hands adjust to the real, not the illusory, size.[21] Thinking is an occasional adjunct to this integrated, whole-brain process, not the Grand Conductor, standing outside the neural orchestra and telling it what and how to play.

The perceptual underpinnings of intelligence seem only to develop in the context of purposeful action and movement. A kitten that receives rich and varied visual experience, but gets it by being carried around, not by using its own legs and acting on its own curiosity, fails to develop a functioning perceptual system.[22] What a young animal sees only has meaning and significance in terms of its motivated interactions with the world – what it is currently 'up to'. A baby that could not smile, cry and squirm would have nothing to tell it which changes in its sensory world mattered, and which did not. In learning to touch, squeeze, nibble and throw objects, it is learning how to perceive them – and what meaning and potential 'hey hav'.

Contrary to the emphasis in education on attending, recognising and understanding as ends in themselves, biologically these cognitive processes are always secondary to *getting important things done*. (It is worth remembering that the word 'mind', used as a verb, means 'to care about', and that being 'thoughtful' means being both reflective and considerate.)

What counts as the body is not just 'what's inside the skin'; the brain creates a variety of different

'Students used to be taught about the body's three control systems – the endocrine or hormone system, the immune system, and the central nervous system – as if they were separate. They aren't.'

16. Quoted in Karl Albrecht (2007) *Practical Intelligence; the art and science of common sense*, San Francisco: Jossey-Bass

17. MIT Robotics Lab Director, Rodney Brooks' Foreword to Rolf Pfeifer and Josh Bongard (2007), *How the Body Shapes the Way We Think: A New View of Intelligence*, Cambridge: Bradford / MIT Press, p. xv.

18. See note 25.

19. For a recent summary of this research, see Anthony Chemero (2009) *Radical Embodied Cognitive Science*, Cambridge, MA: Bradford/MIT Press.

20. Richard A. Abrams Christopher C. Davoli, Feng Du, William H. Knapp III & Daniel Paull (2008) Altered vision near the hands, *Cognition*, 107(3), 1035–47.

21. In the Titchener Circles illusion, for example, a circle surrounded by smaller circles looks bigger than the same circle surrounded by larger circles. David Milner and Mel Goodale (2006) *The Visual Brain in Action*, Oxford: Oxford University Press

22. Richard Held & Alan Hein (1963) Movement-produced stimulation in the development of visually guided behaviour, *Journal of Comparative & Physiological Psychology*, 56, 872–876

body maps and images to help it do smart things, and these maps are surprisingly malleable and sophisticated. Body maps extend to include spectacles, pens, walking sticks, squash racquets and prostheses of all kinds. 'The backbone of the story of human evolution has been the story of perfecting our knack for incorporating an increasing sophisticated assortment of physical tools into our increasingly flexible body schemas'.[23] A simple science-based party trick, the 'Pinocchio illusion'[24], can give you the compelling feeling (with your eyes shut) that the tip of your nose is half a metre out in front of your face. Another such 'trick' can make you 'feel' a pinprick in a plastic arm lying on the table in front of you. The human body turns out to be a psychological construct, as much as a physical one.

2. Body and mind are closely interlinked

Emotion and reason are not controlled by different, antagonistic sets of circuitry in the brain. There are many structures in the brain, such as the anterior cingulate and the insula[25], where cognition, feeling and goals are deliberately brought together and integrated. The brain does not have to control or suppress emotion in order to be intelligent. The basic idea of an antagonistic relationship between reason and emotion does not square with the biological facts. Our emotional systems have evolved to help us out in tricky situations, and they are fundamentally intelligent guides as to how to act. However, these systems get tuned and modified by experience, sometimes leaving us with reactions that were appropriate once, but misleading now.[26]

Students used to be taught about the body's three control systems – the endocrine or hormone system, the immune system, and the central nervous system – as if they were separate. They aren't. They are connected in much more immediate and complicated ways than we used to think. The brain responds instantaneously to changes in the concentration of peptide molecules in the immune system, for example – so much so that immunologist Francisco Varela[27] has described the immune system as 'the body's second brain', and peptide molecules as 'bits of brain floating round the body'.

Conversely, changes in what you are thinking have immediate effects on endocrine chemicals such as adrenaline and oxytocin (and thus affect sweating, digestion and even the composition and flow of breast milk). In medicine, 'psychosomatic' no longer means 'made up' or 'malingering'; it is a science-based recognition of the fact that thoughts and feelings, on the one hand, and pain and disease, on the other, are two manifestations of the workings of the same integrated system.[28]

One area in which body and mind are obviously linked together is imagination. Using our imagination to solve problems, imagine futures, rehearse presentations or see other people's point of view is clearly a valuable and highly intelligent asset – one which is now quite well understood in terms of what is going on in the brain. When we look at a situation 'though other people's eyes' we know which bits of the brain become active; and people who have damage to those bits of the brain are unable to show empathy. When we mentally rehearse a skill, brain networks specific to that skill become active, and are modified as a result. As we shall see in more detail later in this report, imagination is a proven amplifier of learning, and scientists can show what is happening in the brain when we learn though imagination, and why. The potential of mental rehearsal in the context of practical learning has hardly begun to be tapped, yet it is clearly significant.[29]

3. Our bodies are cleverer than we thought

The way we carry out complicated actions depends as much on the physical properties of the body as it does on central control from either mind or brain. We are intelligent because of, and in the context of, the way our fingertips deform under pressure, and the elasticity of our bones and muscles. Programming a robot to run on a level but uneven surface is very difficult, if you start from scratch with metal legs and try to load all the control into a central 'brain'. But you can build quite a simple mechanical toy that will totter down a slope if you design the joints right. Starting with that, and then modifying it to work on the flat, turns out to require a whole lot less 'central computing power' and is much more lifelike and successful. Artificial intelligence researchers used to think all the intelligence lay in the central computer, and it didn't matter much what you housed it in. They don't think so any more – they know the 'mind' is not at all independent of the 'body'.[30]

'Using our imagination to solve problems, imagine futures, rehearse presentations or see other people's point of view is a valuable and highly intelligent asset'

23. For a good summary of this research, see Sandra and Matthew Blakeslee (2007) *The Body Has a Mind of Its Own*, New York: Random House, New. The quotation is taken from page 147

24. See www.viswiki.com/en/Pinocchio_illusion

25. The anterior cingulate is the front part of the cingulate cortex and sits like a collar around the bundle of nerves called the corpus callosum. Insula (an abbreviation for insular cortex) is a part of the brain implicated in various emotional responses.

26. Jaak Panksepp (1998), *Affective Neuroscience: The Foundations of Human and Animal Emotions*, Oxford: Oxford University Press; Edmund Rolls (1999) *The Brain and Emotion*, Oxford: Oxford University Press. Many approaches to psychotherapy involve the retraining of these emotional habits

27. Francisco Varela and Antonio Coutinho (1990), Immune networks: getting on to the real thing. *Research in Immunology*, 140, 837–846.

28. Candace Pert (1997), *Molecules of Emotion*, New York: Prentice-Hall; Francisco Varela et al, Cognitive networks: immune, neural and otherwise, in Alan Perelson (ed) (1988), *Theoretical Immunology*, New Jersey: Addison-Wesley

29. Jean Decety and Jennifer Stevens (2009), Action representation and its role in social interaction, in Keith Markman et al (eds), *Handbook of Imagination and Mental Simulation*, New York: Psychology Press

30. See Pfeifer and Bongard, op. cit. p 363; Steve Collins et al (2005) Efficient bipedal robots based on passive-dynamic walkers, *Science*, 307, 1082–1085

The exploration of neural networks – simplified computer simulations of how brains might work – have shown that lots of individually very simple neuron-like elements, wired together in particular ways, can learn to do very intelligent things, despite having no articulate or conscious 'supervisor' anywhere in the system. They can recognise human faces under varying conditions of light, distance, orientation and dress; they can read emotions from people's faces, again under a wide range of conditions; they can learn to play chess pretty well; they can make up children's jokes quite well; and they can determine your credit-worthiness better than your (human) bank manager can. When such brain-like systems are housed in the right kinds of bodies, and placed in the right kinds of physical worlds, they can behave in ways that make an observer swear that there must be some kind of 'central intelligence' controlling the system – but there isn't. There is a growing suspicion amongst researchers that we human beings, despite having a strong sense that 'we' are in control, are actually built in this embodied, self-organising way.[31]

4. Physical movement helps thinking

Physical gesturing and gesticulating have been shown to be important components of thinking and talking: not mere ornamental accessories, but significantly embroiled in the thinking process itself. Children who are made to sit on their hands have been shown to think less intelligently about a maths problem than those who are free to gesture. And their gestures give evidence of more sophisticated understanding of mathematical concepts than they are yet capable of articulating verbally. It has been suggested that we are able to 'think more freely' with our hands than with our mouths, and thus that gesturing is integral to creativity.[32]

If you ask people 'when they get their best thoughts', they often say 'in the shower', 'walking the dog', 'doing my lengths in the pool', 'driving to work' and so on. There seems to be something about repetitive activity that puts the brain into a conducive state for creative thinking. Philosophers are known to jump up and pace about in the middle of a vigorous discussion. Creative cognition often seems to work better when it is accompanied by some kinds of physical movement. John Allpress, Head of Youth Player Development at the Football Association, says that footballers are often the kinds of people who 'can only think when they are moving'. The same is true of dancers.[33]

Even memory is sometimes tied to movement. Actors learn their lines in terms of where they are standing and how they are moving, and their memory is often thrown when a scene gets re-blocked late in rehearsals. People who are allowed to doodle whilst listening to a long telephone answering machine message show 30% better attention and retention than those who are not. (To be able to think *without* moving may be a very recent trick acquired by the brain, requiring a sophisticated deployment of inhibitory activation to block movements that would otherwise have taken place.)[34]

It's not just moving that shapes the way we think: our physical postures and facial expressions also change our minds. When people are induced to slump in their chair, they feel less pride in their performance, think less carefully about problems, take their own thoughts less seriously, and show less resilience in the face of difficulty. And the magnitude of these effects is different for different people. Some people seem to have managed to disconnect their minds from their bodies more than others.[35]

Neuroscientists have suggested, on the basis of the anatomy of the brain, that language itself began as a kind of sign language and has never quite outgrown its gestural origins; and that mathematics, too, grows out of brain regions that are associated with counting on the fingers.[36] Indeed, one recent study has shown how much neuroscientists themselves rely on gesture when they are trying to explain complicated neuroimages to each other![37]

5. Much thinking is not conscious

The brain does very clever things without the aid of consciousness. A lot of learning happens without conscious intention or supervision. Brains can detect and make use of faint patterns of information that are too subtle for minds to be able to grasp. In one study, people had to spot which quadrant of a screen of numbers contained a specified digit. Every so often, the location of the target was a complicated function of where it had been on a few of the previous trials. Nobody spotted this

'Children who are made to sit on their hands have been shown to think less intelligently about a maths problem than those who are free to gesture'

31. See Manfred Spitzer (1999) *The Mind within the Net*, Cambridge MA: Bradford / MIT Press

32. Susan Goldin-Meadow and Susan Wagner (2005) How our hands help us learn, *Trends in Cognitive Science*, 9(5), 234–41.; Andy Clark (2008), *Supersizing the Mind*, Oxford: Oxford University Press.

33. John Allpress, personal communication; Gillian Lynne, choreographer of *Cats*, as told to Ken Robinson (2009) in *The Element: How Finding Your Passion Changes Everything*, London: Allen Lane

34. Jackie Andrade (2009) What does doodling do? *Applied Cognitive Psychology*, online doi.10.1002/acp.1561.

35. Pablo Brinol and Richard Petty (2008) Embodied persuasion: fundamental processes by which bodily processes can impact attitudes, in Gün R. Semin, Eliot R. Smith (eds), *Embodiment Grounding: Social, Cognitive, Affective and Neuroscientific Approaches*, Cambridge: Cambridge University Press.

36. David Armstrong, William Stokoe and Sherman Wilcox (eds) (1995) *Gesture and the Nature of Language*, Cambridge: Cambridge University Press; Sandra and Matthew Blakeslee, op. cit., pp 148–9.

37. Morana Alac and Edwin Hutchins (2004) I see what you are saying: action as cognition in fMRI brain mapping practice, *Journal of Cognition and Culture*, 4(3), 629–661.

pattern consciously – yet they all got faster on the critical trials, showing that their brains had picked up the information unconsciously. People are clearly making use of such information to become more skilful, but they can't explain how they are doing it or what they have (unconsciously) noticed. Our bodies are continuously transmuting subtle information into intelligent control – without telling us – the conscious 'us' – what they are up to. That's why many expert doers and performers are unable to explain how they do what they do.[38]

Even the old idea that 'sleeping on it' can help you be more creative turns out to be confirmed by neuroscience. A period of sleep seems to help the brain to find links between unlikely ideas that can lead to the creative breakthrough. And sleep can also help you get out a rational rut that is stopping your brain going where it needs to.[39]

Indeed, conscious thinking often gets in the way of intelligent choosing and acting. When trying to master a computer game that behaves in a counter-intuitive way, people encouraged to try to figure out consciously what is going on learn more slowly than people who are encouraged to play the game more 'thoughtlessly'. People facing a difficult decision, having been given lots of different considerations to weigh up, do better if they have a 10 minutes wait before deciding *in which they are prevented from thinking about the problem.* As in many areas of life, people's golf game falls apart if they start to think too much about what they are doing. That much-vaunted conscious reasoning process is actually irrelevant to some kinds of intelligent action, and actively disruptive of others.[40]

Adherence to conscious clarity and explanation turns out to hold learning back in a deeper sense. Berkeley philosopher Hubert Dreyfus has analysed the development of expertise, in many different vocations, into five stages through which a person passes on their way from being a novice to becoming a virtuoso. In the first three phases, *novice*, *advanced beginner* and *competence*, the learner moves from following general rules of thumb through more context-sensitive rules and maxims to possessing a highly developed framework of knowledge and understanding to guide action. Experience in these phases tends to be relatively dispassionate and 'technical'.

However, as learners move into the phase of *proficiency*, and beyond into true *expertise*, their *modus operandi* becomes more imbued with feeling and intuition. They develop hunches and sensitivities about their craft that defy explication. Their experiential mastery becomes more subtle than can be accurately captured in words. Conscious deliberation now occurs only at occasional moments of indecision, or in the context of high-level strategy-selection. At these advanced stages, therefore, to continue to cling to conscious comprehension is to hold yourself back from developing full expertise. And a teacher or an education system that insists on testing explicit understanding therefore arrests their learners' development at an intermediate stage of mere competence or mediocrity. As Dreyfus said at a symposium in Birmingham in 2008, 'If you can explain it, you don't *really* understand it'[41]

A much-touted (though little researched) model of learning suggests that learning proceeds through four stages from *unconscious incompetence* through *conscious incompetence* to *conscious competence* and finally on to *unconscious competence*.[42] This model acknowledges that expertise often rolls out without thinking; but it continues to assume that learning itself is conscious and deliberate. Sometimes it is – but often we progress from 'unconscious incompetence' to 'unconscious competence' without the intervention of the conscious middle-man at all! Children learn to walk without talking to themselves about it, and adults continue to learn many skills in the same way.

Scientists now largely agree that consciousness, though mysterious, is a product of the activity of bodies with complex nervous systems going about their business in the world. When certain bodily events occur – sleep, a blow to the head, a stroke – consciousness is lost or changed. But the intact Brain-Body-Context System generates conscious experiences of knowing (or believing or seeing or feeling) of many different kinds. Some are verbal, logical and reasonable. Some are what we call 'perceptions' or 'images' or 'hallucinations' or 'memories'. Some are what we call 'emotions' or 'feelings' or 'moods', and these are associated with experiences that we think of as belonging to the body as well as the mind. We also experience forms of 'knowing' called intuitions, hunches,

'Thousands of young people who are good with their hands and feet, but not so good with equations and prepositions, have been led to think that their talents and interests are second-rate'

38. Pawel Lewicki et al (1992) Nonconscious acquisition of information, *American Psychologist*, 47, 796–801; Guy Claxton (1997) *Hare Brain, Tortoise Mind: Why Intelligence Increases When You Think Less,* London: Fourth Estate.

39. Ullrich Wagner, Steffan Gais, Hilde Haider, Rolf Verleger and Jan Born (2004) Sleep inspires insight, *Nature*, 427, 352–355. Mark Holmes, Art director at Pixar Animation Studios, summed it up (in a science article in the *New York Times*, 12/10/08): 'You can get tunnel vision when you're hammering away at a problem. You keep going down this same path, again and again, just tweaking, making incremental changes at best. Sleep erases that. It resets you. You wake up and realise – wait a minute! – there is another way to do this'.

40. Chen-Bo Zhong, Ap Dijksterhuis and Adam Galinsky (2008) The merits of unconscious thought in creativity, *Psychological Science*, 19(9), 912–918; Kristin Flegal and Michael Anderson (2008) Overthinking skilled motor performance: or why those who teach can't do, *Psychonomic Bulletin and Review*, 15(5), 927–932.

41. Hubert and Stuart Dreyfus (1996) *Mind over Machine: The Power of Human Intuition and Expertise in the Era of the Computer*, New York: Free Press

42. The model was apparently devised and promoted by a commercial training organisation, US Gordon, in the 1970s.

inklings, and being 'touched' or 'moved', and these too have physical properties as well as perceptual or cognitive ones. Then there are what we call 'promptings' and 'impulses' and 'attractions', that are associated with the physical readiness to act in certain ways. The financier George Soros, sums up this aspect of 'embodied knowing' like this[43]:

Realising that logic alone cannot be the basis of successful speculation led me to study bodily knowing in my post-doctoral research. There's a whole side to our embodied, experiential knowledge that computers don't have and that the 'rational economic man' in models most economists construct doesn't have either. Our bodies 'know' the situations we meet in life and how they can unfold. I found that physical experience has much more organised knowledge about the world than the usual understanding of the body admits.

We have known for some time that certain injuries to the frontal lobes of the brain leave rational intelligence intact, but disconnect it from physical sensations of emotion and intuition. When this happens, people are able to articulate choices and decisions, but not to carry them through into action. To put it crudely, they talk clever but act stupid. Apparently these bodily sensations, what Antonio Damasio calls 'somatic markers', are essential to glue comprehension and competence together. Abstract intelligence, decoupled from its essential partner, the body, turns out to be clever at reasoning but bad at living.[44]

Practical and academic learning are much more alike than we thought

This very brief review of research from a wide range of current paradigms makes it clear that brains, bodies and minds are much more closely tied together than the traditional model would have had us believe. Conscious mental experience accompanies some intelligent cognitive operations, and not others. Explicit rational thinking sometimes supports intelligent behaviour and sometimes gets in the way. Abstract reasoning seems to *interfere* with the operations of human intelligence, as often as it supports them.[45] Even mathematics turns out to have it roots in the physical fabric of the body (and not to have been borne down from heaven on the wings of angels).[46] Intellect is one aspect of our intelligence, but by no means the only one, nor always the best one to make use of. Emotion and imagination are grounded in the intricate processes of the physical body, yet are vital elements of real-world intelligence. If there ever was a rationale for universally valuing rational debate, mathematical computation and essay-writing above intuition and imagination, it has been comprehensively swept away in this flood of fascinating new neuroscientific research.

So cognitive science and neuroscience are turning those old Cartesian assumptions – that mind and body are separate, and one is clever and the other isn't – upside down. It turns out, on closer inspection, that the meat of which we are made is very clever indeed. It is no longer unthinkable that the brain, and the body of which it is an organ, could underwrite cognitive complexity, the use of language, mathematical computation and propositional reasoning.

We still haven't a clue *why* embodied brains should generate conscious experience. Indeed, knowing that brains are capable of all kinds of intelligent operations *without* conscious control or observation, it is the function of conscious reasoning itself that is looking increasingly problematic. The strong likelihood now is that the fundamental organ of human intelligence is not the brightly-lit front office of the conscious mind, but the dark, silent physiological factory that lies behind. Conscious trains of thought are not the *workings* of intelligence; they are intermittent – and often rather unreliable – indications of what is going on behind the scenes.[47] And if the body turns out to be the seat of *all* human intelligence, it seems perverse to value one set of its products – the verbal, let's say – above any of the other subtle actions and promptings through which the body makes its intelligence known.

That perversity is perhaps a hangover from a bygone age – a kind of epistemological appendix that now causes trouble and is better off removed. Before Darwin, human identity was shaped by the need to give pride of place to qualities that we had but animals (and young children) didn't – principally, language and explicit reason. Post-Darwin, we are no longer threatened by the thought of our continuity with the rest of the animal kingdom, and can thus rejoice as much in the kinds of embodied intelligence which we seem to share

'A teacher or an education system that insists on testing explicit understanding arrests their learners' development at an intermediate stage of mere competence or mediocrity'

43. George Soros (2006) quoted in Malcolm Gladwell, *Blink: The Power of Thinking without Thinking*, London: Penguin

44. Antonio Damasio (1999) *The Feeling of What Happens*, London: William Heinemann. The small region referred to as the 'right frontal insula' is especially implicated.

45. Jonathan Schooler, Stellan Ohlsson and Kevin Brooks (1993) Thought beyond words: when language overshadows insight, *Journal of Experimental Psychology: General*, 122, 166–183.

46. George Lakoff and Raphael Nunez (2000) *Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being*, New York: Basic Books

47. Chris Frith (2007) *Making Up the Mind*, Oxford: Blackwell; Guy Claxton (1994) *Noises from the Darkroom*, London: HarperCollins; Francis Crick (1995) *The Astonishing Hypothesis*, New York:: Scribner

as in the verbal capacity that seems to set us apart. Hands-on exploration of the physical world is not only for children, and we do not need to assert our adulthood by denying our abiding embodiment.

What might these recent developments and findings in the world of neuroscience mean for raising the esteem of PVL? Principally, they suggest that there is not only intrinsic value and satisfaction in practical learning, but that it is in fact essential if we are to fully understand the world. Handling materials and literally 'getting to grips' with problems allows us to see things and inform our understanding in ways that simply looking and thinking do not. Practical learning is a fundamental part of our natural intelligence; it is not the preserve of those deemed 'not bright enough' to reason tightly and use long words. Careful thinking complements and augments practical learning, it does not supplant it. It is not that practical learning needs to be made more intellectual; we could argue that conventional 'academic' education needs to capitalise more on the 'hands on-ness' of practical learning. What we may need is a more balanced view of education that avoids unhelpful distinctions between 'academic' and 'practical' – learning for 'the bright ones' and learning for 'the less able' – and instead see learning as the holistic process that it is, which requires handling and moving as well as thinking.

Once the kind of information we have been reviewing in the last few pages gets out, it must surely spur a reconceptualisation of the relationship between body and mind. This will in turn require shifts in the way many of our social institutions and professions operate. If true expertise depends on embodied knowledge that is *in principle* not capable of full description and explanation, then its assessment must be practical and not just intellectual, for example. Practices of assessment in many schools of medicine, engineering and law will have to change if this information is taken on board. So will the understanding and place of 'clinical intuition'. Issues of accountability will have to be re-thought, if the construction of a plausible rationale, to be used as a defence against litigation, means that a surgeon feels obliged to 'pull back' from making full use of her intuitive expertise. Many such changes, too many and intricate to be spelt out here, can be expected to occur.

Eight myths about PVL

But it is with the implications for 'practical and vocational education' (PVE) that this report is principally concerned. To see what this balanced view entails in more detail, it is useful to lay out clearly the misconceptions of practical learning that have long made it the junior sibling of scholarly learning. So let us review some of the attitudes that seem to underlie PVE – the attitudes and assumptions that have emasculated previous well-intentioned attempts to raise its status – and see where they might now be in need of revision. It is clear that Descartes' error is at the core of a number of these familiar beliefs. The myths include the following, each one of which is spelt out in italics.

1. Practical learning is cognitively simple.
'PVE basically involves watching demonstrations, understanding instructions and practising until you can 'do it'. So physics and economics require thinking that is intricate and difficult, but horticulture and plumbing just require the memorisation of facts and formulae, and mastery of procedures.'

This belief is looking increasingly suspect. Developing expertise requires concentration, practice, imagination, critical thinking and self-evaluation, as well as knowledge and understanding. These all have to be woven together in practice in increasingly intricate ways. As people get better at germinating seedlings or styling hair, they can also be developing more sophisticated and fluid forms of dynamic cognition. Tracing and rectifying a fault in a photocopying machine or a complicated heating system may well require sophisticated knowledge, memory, reasoning, attention to detail, imagination, experimentation and communication. Links need to be made, possibilities explored, tested and revised, conversations with other experts held. The expertise of the boiler engineer and the mechanic is revealed through these fluid forms of cognition. Yet the educational journey required to build this foundation of knowledge remains maligned. Perhaps a greater appreciation by articulate 'knowledge workers' of what they *cannot* do might be a step towards an appreciation of the knowledge and skills of successful vocational learners.

'Handling materials and literally "getting to grips" with problems allows us to see things and inform our understanding in ways that simply looking and thinking do not.'

2. Clever people 'grow out of' practical learning

'Practical learning is typical of the child; cerebral learning is typical of adults. Growing up means moving from practical to cerebral ways of learning and thinking. Learning by watching and trial-and-error is what people do when they don't have more powerful learning tools at their disposal. The job of education is to get young people to move from physical to cerebral ways of learning as quickly as they can. When you have begun to master a more powerful way of learning, you can rely less and less on the more primitive ones.'

The gestures of an academic, the physical sensibility of a potter, and the acute perception of a poet are no mere hangovers from childhood; they are integral to their real-life intelligence and performance. The idea that 'sensorimotor learning' is a simple form of learning to be outgrown is false, and a hangover from the days before embodied cognition. As children grow, so they add more 'instruments' to their cognitive ensemble – principally imagination, rational argument and self-awareness – but these supplement the earlier ones, they do not supersede them. Each can continue to grow in sophistication, and each has to find its proper place in the dynamic workings of the larger ensemble.

Practical learning need be neither menial nor simple. People's 'brains' are stretched, and their mental powers extended, as they plan and build a staircase from scratch or design and lay out a brand new garden. These are large tasks that require huge amounts of careful thought and planning. As craftsmen grow in skill, so they come to realise why, for example, certain steps are done in a particular order, or how the 'tricks of the trade' improve productivity, add aesthetic value or reduce potential risk or personal frustration. The ability to draw on and apply experiential learning is both developed and revealed in the processes of skilled craftsmanship. The learning is subtle and protracted – lifelong, in fact – so we must reconceptualise our view of the motivations of learners drawn to PVE, and think carefully about designing the first steps on the long road to becoming the skilled artists or technicians whose work we admire.

3. You have to understand something before you can (learn how to) do it.

'Being able to talk (or preferably write) about what you are doing or explain the basis of a skill is a necessary precursor to being able to do it – or if not necessary, then at least very helpful. Comprehension is prior *to competence. Sometimes people even assume that comprehension is* sufficient *for competence – if you can explain and describe it, then somehow you ought to be able to do it. If you can't talk or write about it, you haven't learned it 'properly'.'*

This assumption is false, as much of recent experimental work on 'implicit learning' and skill acquisition makes abundantly clear. Many skilled activities suffer from 'thinking too much', both during learning and during performance. The continued acceptance of this assumption as a rationalisation for much of the present examination system is untenable and unacceptable. Ask a top-ranking snooker player and he (or she) may not be able to describe what is going on in mind or body as he builds a century break, imagining the table two shots ahead, totting up the score, calculating angle and spin, while, perhaps, also trying to put out of his mind the bad mistake of a few moments ago. A dedicated hairdresser may likewise struggle to explain how and why she makes the practical judgements and choices that he or she does.

Challenging this misconception opens up possible lines of thought for anyone interested in really understanding PVE. The recent research implies that not only do learners gain much more from 'getting hands-on', but (as Hubert Dreyfus' earlier comment attests) the pressure to keep explaining what it is you are doing can be an obstacle to developing further expertise. The pressures of the UK's assessment-driven education system require many practical learners to not only continually explicate their learning, but to do so in written rather than practical form. A greater appreciation of how this relates to the real world might help educational policy-makers regain some perspective: how many of us would rather a motor mechanic produce a written account of how to carry out an MOT on your car: surely we would prefer that he (or she) can perform this task to the highest level of competence?

'The pressure to keep explaining what it is you are doing can be an obstacle to developing further expertise'

4. Clever people don't get their hands dirty

''Bettering yourself' means not being as physically tired and grubby at the end of the day as your parents were. Self-improvement used to mean, first, not coming home covered in coal dust, smelling of fish, or with blisters and a sore back, and then (maybe) not coming home with eye-strain and inky fingers. The best kind of jobs are those where physical strength or dexterity don't matter at all, but where you do lots of talking, arguing and decision-making (and where other, less intelligent or well-educated, people get to carry out what you have decided).'

This social assumption about the meaning of 'self-improvement' runs deep in many societies, but is open to question. There is an in-built assumption within society that to gain promotion to senior management or to own one's own business is to have 'made it'.[48] For many who work in professions, trades and industries that require and prize practical skills, and who 'make it' in this way, such responsibility often means that they become somewhat detached from practical work. Indeed, as we can see, the language we use indicates such separation: we talk of 'having made it'; 'moving upstairs' and refer to 'life at the coalface' or 'on the shop floor'.

Yet many highly successful professional and vocational experts derive as much joy from the manual and bodily activities they practise at weekends and on holidays as they do from their Monday to Friday 'brain work'. There are university vice-chancellors who get as much satisfaction from their wind-surfing as their faculty restructuring, senior civil servants who lavish as much care on their rose gardens as their policies, and highly-paid surgeons who get as much fulfilment from their golf as from carrying out a tricky orthopaedic procedure.[49] Conversely (if less socially 'influential') a male carpenter may well be part of a 'dads and lads' book group or a nurse choose to spend time as a parent governor. The 'either-or' assumption that forces apart 'physical' and 'valuable' is both false and harmful.

5. Clever people don't 'need' to work with their hands.

'They don't especially enjoy physical work, or find fulfilment in the processes of making and doing. Basically there are two kinds of people: those who feel proud when they have done The Times crossword, or written a persuasive position paper for a board meeting, and those who feel proud when they have done a complicated wheelie for the first time, or managed to propagate a magnolia cutting. Life is reduced either to living in the ivory tower or working on the factory floor.'

This is again highly questionable. Many kinds of people need to be intelligent both with their hands and with their thoughts. Try imagining how an engineer on site, an earth scientist or a talented sculptor would react to this proposition. It has even been suggested that practical learning is a better 'breeding ground' for the development of generic attitudes and dispositions towards lifelong learning than is academic learning.[50]

As we saw earlier, embodied cognition suggests that learning of all kinds has a physical component. Yet conventional apprenticeships often locate hand-on learning in the work-place, and sedentary 'book-learning' in the college or the classroom. There are lines of thought here for those who design PVE, about how to bring more thinking into the practical context, and more 'doing' into the theoretical context. The best vocational teachers show, by example, that they can still 'do', and can model what it is to be a learner 'doer'. When they reveal the ways in which they grapple with practical learning, the thinking and imagining that went on behind the scenes becomes overt and thus demystified.

6. Practical education is only for the less 'able'.

'If you are 'bright enough', you go to university and 'read' (notice the deep prioritisation of literacy) history or law. If – sadly – you aren't, you go and train to become an electrician or a gardener. If you got a place at Oxford and turned it down because you really wanted to become a great hairdresser or a rock guitarist, you would be seen as 'throwing away your talent'.'

This is perhaps the core error that we have to expose and eradicate. There are many forms *of* intelligence, and many intricately interwoven elements *to* intelligence. Some of these are abstract and logical, others are embodied, intuitive, social and physical.[51] Different phases and domains of intelligent activity require different mixes of these elements at different times. Students differ in their shifting and situated profiles of intelligence. One might be highly resilient and

'The "either-or" assumption that forces apart "physical" and "valuable" is both false and harmful'

48. As in the ironic cry of the newly promoted manual labourer: 'The working class can kiss my arse; I've got the foreman's job at last!'. The full 'Battle Hymn of the New Socialist Party', from which this comes, can be found at http://en.wikipedia.org/wiki/The_People's_Flag_Is_Palest_Pink . This societal assumption is, of course, often embodied in pay differentials. People who want to continue to practise their craft, rather than become managers, have to forgo income to do so.

49. We do not have formal evidence for this conjecture, though informal testimony suggests there is much truth in it. There is an interesting research project to be pursued here.

50. For example, nursing now acknowledges the importance of expert 'float nurses' who are especially good at very quickly 'getting their head around' a wide variety novel situations. See Patricia Benner et al (1996) *Expertise in Nursing Practice*, Berlin: Springer; Sennett, *The Craftsman*, op. cit..

51. See Bill Lucas and Guy Claxton (2010) *New Kinds of Smart: How the Science of Learnable Intelligence is Transforming Education*, Buckingham: Open University Press

have great sensibility for material; another might be able to sustain concentration on difficult text, but not on their practical work. The idea that 'ability' is a single continuum along which all students can be graded is false and dysfunctional.[52]

7. Practical learning involves only lower order thinking

'Practical learning is a matter of 'acquiring skills', while academic learning involves imagination, cogitation and a much more sophisticated attitude towards knowledge and understanding. Skills are technical, relatively clear-cut, trainable, and, once acquired, available whenever they are appropriate. Once you have been 'trained' in a 'skill' (or a 'trade'), you go out and practise it (with occasional short refreshers and updatings), whilst an educated mind thirsts for ever-deepening understanding.'

Minds are more embodied and more complex than schools and colleges typically allow. And so is the world. Very few occupations are either purely cerebral, or purely physical. Scientists need rational thinking to design a good experiment, but they also need a 'feel' for their apparatus, and the good sense to balance hard thinking with intuition, imagination and incubation. Sports coaches need to think and plan as much as they need to exercise and demonstrate. Playing with a restricted deck of intelligences, people can be dull lecturers and inflexible solicitors, just as well as they can be limited plumbers or unimaginative beauticians. A dance teacher without empathy is as restricted as an accountant without imagination. Occupation is no predictor of intelligence. For some professions and trades, embodied intelligence matters a lot, and debating skill counts for less; for others, *vice versa.*

Points six and seven reveal the risks in perpetuating the myth that the products of scholarly learning are intrinsically more valuable than the products of practical or vocational learning. This is patently not the case, as a 2009 study by the New Economics Foundation makes clear. They mount a strong case that lower-paid hospital cleaners, recycling plant workers and childcare workers can be seen as doing more valuable work and make a greater contribution to society than highly-paid City bankers, advertising executives and tax accountants[53]. From an aesthetic point of view, the world would be a poorer place without sculptors, filmmakers, musicians and landscape gardeners, to name just a few of those craftspeople that earn a living through their practical skills. Those whose work we admire we would hardly call 'less able'.

It is up to educators and parents to nurture and not deride talent and enthusiasm for practical learning and skill-building. A major part of PVE should be to strengthen in young people an ineradicable belief that there is as much dignity and pride in working with your hands as there is in writing and arguing for a living. Even if one chooses not to earn a living from one's practical talents, as we argue above, they are often essential to one's physical and mental wellbeing in other aspects of life.

8. Practical teaching is a second-rate activity

'Given the 'lack of complexity' involved in practical learning it follows that teaching practical learning is less sophisticated and demanding activity than teaching Shakespeare or thermodynamics. Therefore it is right that those who teach in Further Education Colleges (where much practical teaching occurs) should have less non-contact time (because their preparation ought to be easier), be less expected to undertake 'intellectually demanding' research, and be paid less, than University Lecturers.'

It follows from everything we have said that this is both false and unjust. In many cases PVE teachers and lecturers are in the business of cultivating a broader portfolio of intelligent skills and attitudes than those who teach more academic subjects. It is also the case that they may have to work harder (and smarter) to rectify dysfunctional learning habits, beliefs, attitudes and self-perceptions that their students may have acquired over years of schooling. Undoing these errors, and helping practically and vocationally-inclined young people to develop their learning potential, and, in many cases, regain their self-respect, is a highly skilled and significant activity, and one which should be valued accordingly.

As the New Economics Foundation study cited above makes clear, it is a mistake to equate how much someone is paid with their value to society or their level of personal satisfaction they can derive from their occupation. Teaching in PVE entails much more than imparting skills and knowledge: there is the need to teach young people how to apply theory to practice, and to instruct and advise

'There are many forms *of* intelligence, and many intricately interwoven elements *to* intelligence'

52. Howard Gardner's theory of 'multiple intelligences' suggests that there are eight or nine key domains of human activity each of which requires a different kind of cognitive strength or orientation. The argument here is slightly different: that there is a kind of core intelligence, but that it comprises a host of elements and aspects each of which, to a significant extent, is learnable and improvable. See Howard Gardner (1999) *Intelligence Reframed: Multiple Intelligences for the 21st Century*, New York: Basic Books; and Lucas and Claxton op. cit.

53. Eilis Lawlor, Helen Kersley & Susan Steed (2009) *A bit rich: Calculating the real value to society of different professions*, London: New Economics Foundation

on the many aspects and expectations of the workplace culture. FE teachers are expected to act as a link between the classroom and the workplace on courses that have significant components of work-based learning. The skills and techniques required to support and help young people make the most of their experiences in classroom and work contexts are far from simple and each student's requirements in this regard are likely to be different (see section in Chapter 6 on learning transfer).

In sum, it is our belief that misrepresenting the nature and underestimating the complexity of practical (and therefore of much vocational) *learning* contributes substantially to the perpetuation of many of the misconceptions about the vocations. For the sake of brevity, we have painted these misconceived attitudes towards PVE in primary colours, but we are sure that they, or only marginally more sophisticated versions of them, are pervasive and widely recognisable, certainly in British society, and across much of the world. Spelled out, and reappraised in the light of the science of embodiment, many of them are self-evidently untrue and/or dysfunctional.

Of course, many educators have long known of the intricate connections which exist between mind and body and the important role of physical activity in absorbing abstract concepts and learning practical skills. Many of those inspired by, for example, the pioneering work of Maria Montessori have seen the benefits of this at first hand.[54] Now, however, we have hard science to back up this experience, and to encourage educators to see that what is obviously appropriate for a four-year-old may well be of much greater relevance to a 17-year-old (or a 50-year-old) than we had previously thought.

Conclusions to Chapter 1

Research on embodied cognition lays the ground for a radical reappraisal of practical learning, and thus of practical and vocational education. If philosophers need to walk to argue, and neuroscientists need to gesture to explain, then equally, carpenters must make full use of their reasoning and sports coaches of their imagination. Philosophising and interior design, at their best, draw on the full range and depth of human intelligence. Practical (and much vocational) learning is not 'simple' at all; it involves a delicate synthesis of different learning modes. The 'somato-cognitive' (i.e. body-mind) mix will be different for a radiologist and a plumber, or a novelist and a hairdresser, say, but the same elements of feeling and thinking, moving and imagining, tinkering and appraising, will be present, and woven together in ways that make it impossible to judge the work and the learning of one as less complex or demanding than the other.

Hands, eyes, brains, tools, teams and conscious minds are connected together in intricate and highly intelligent ways. They form a system, in which no one element – certainly not Reasoning – can be picked out and held to be the Boss – instigating, supervising and controlling what the more junior or 'menial' partners have to do. Learning to do skilful things with hands and feet and lungs and physical balance turns out to be no less taxing and creative than learning to do skilful things with speech and writing. Unpacked, and looked at properly, practical and vocational learning is every bit as worthy of our full esteem as the academic learning with which it is so often, and so falsely, contrasted. As Richard Sennett says, 'Every good craftsman conducts a dialogue between concrete practices and thinking; this dialogue evolves into sustained habits, and these habits establish a rhythm between problem solving and problem finding'.[55] That process is intelligent and protracted.

Vocational education – helping people become learning-hotel-managers or learning-vehicle-mechanics – is commensurately intricate, demanding and worthy of respect. Neither a traditional 'Sitting by Nellie' model of passive observation and absorption, nor a pseudo-intellectual diet of diluted sociology or biochemistry, does justice to the learning required. Young people need to build habits of concentration and attention, smart practice and intelligent playfulness, controlled imagination and critical thinking, and helping them develop this mix is a demanding job.

Practical and vocational *learning* does not stop when a learner gets a BTEC or a Diploma; and practical and vocational *education* is not merely

'What is obviously appropriate for a four-year-old may well be of much greater relevance to a 17-year-old (or a 50-year-old) than we had previously thought'

54. See, for example, Angeline Lillard (2007) *Montessori: The Science behind the Genius,* New York: Oxford University Press, for more about this tradition of work and its scientific validity.

55. Richard Sennett, op cit. p 9.

the communication of knowledge and skill. To be a good teacher for practical learning, you have to be a role model, an explainer, a critical friend, and a coach of the 'wider skills' that every learner needs. You have to teach that being an electrician or a beautician is an honourable and difficult lifelong journey, not something you do because you weren't 'bright enough' to do something more academic. Learning to be an electrician can take a lifetime – if you have been set off right, full of curiosity and determination, resourceful and keen to learn more and more – just as learning to be a doctor or a translator can. Imparting such a learning orientation is the job of every teacher – no matter whether their specialism is netball, animal husbandry, astrophysics or classical history.

So the foundations on which the old disparity of esteem between 'practical' and 'academic' has been built have crumbled. The assumption that 'those who can, think, while those who can't think, do' has no basis in science, and no place in an informed and egalitarian society. It is a deeper understanding of the true nature of learning, and the delicate ways in which body and mind interweave on the learning journey, that can rectify that disparity of esteem – not yet another round of tinkering with curricula, qualifications or funding.

'The assumption that "those who can, think, while those who can't think, do" has no basis in science, and no place in an informed and egalitarian society'

Chapter 2
A working model of real-world learning

The original meaning of [the 3Rs] was completely different in Regency times, at the beginning of the 19th century. The three Rs were reading, wroughting and arithmetic – in other words, literacy, making things and numeracy…And then in the era of Mr Gradgrind and the Great Exhibition of the 1850s, the wroughting got dropped in favour of writing.
Sir Christopher Frayling[1]

Can a better, more embodied understanding of the learner's mind help learners learn, and teachers teach, more effectively? The evidence, we believe, is that such an understanding would indeed improve the quality of the learning and teaching that takes place in the context of practical and vocational education. In this and the following two chapters, we draw on established, and in some cases emerging, areas of the learning sciences to describe what is going on at the learner's end of practical and vocational education. Specifically we offer a framework for thinking about what PVL (or as we are calling it 'real-world learning') actually involves, and the qualities of mind that support such learning.

We argue that these qualities are themselves capable of expansion; that young learners can get better at learning and that adults can support them more effectively in doing so. We have reason to believe that when learners and teachers have a more accurate and sophisticated view of what effective practical learning actually involves, learners' engagement, retention, achievement and satisfaction are all likely to improve. We suggest that the framework provides a useful basis for thinking about the design of optimal learning environments. In particular, this framework provides a fruitful way of thinking about education at two levels, the pedagogical and the contextual. At the pedagogical level, it can inform how teachers, coaches and mentors can best design the learners' close-at-hand learning environment. At the contextual level, it offers suggestions about how best to design a school or college that prepares young people for a lifetime of real-world learning.

The framework is deliberately broad enough to cover both practical and intellectual kinds of learning. It provides a common language for thinking about how both artisans and scholars go about their business of learning and problem-solving. We think that the development of such a language is crucial if we are to dispel the pernicious differential of esteem in which these different kinds of accomplishment have traditionally been held. The tacit assumption that generically different models of learning and teaching apply to practical and academic kinds of learning has helped to perpetuate that dysfunctional imbalance.

The constructivist approach

What we are calling the 4-6-1 model derives from a constructivist perspective on teaching and learning.[2] This perspective has gained wide (though not quite universal) acceptance amongst educational researchers, and holds that 'learning' is an activity that takes place in the brains and minds of learners which is influenced, but not controlled, by what teachers are doing. The approach rests on a number of general assumptions about teaching and learning, for each one of which there is a good evidence base. It is important to spell these bases out now as they launch the ensuing discussion in a somewhat different direction from that taken by many

'Teaching does not make learning happen. Good teaching is the effective facilitation of learning'

1. Sir Christopher Frayling, Rector of the Royal College of Arts, interviewed in *The Guardian* 29/6/04.

2. Good summaries of the constructivist position, and its rationale, are provided by Tom Bentley (1998), *Learning Beyond the Classroom: Education for a Changing World*, London: Routledge; John Bransford, Ann Brown and Rodney Cocking (2000), *How People Learn: Brain, Mind Experience and School*, Washington DC: National Academy Press; Anne Jordan, Orison Carlisle and Annetta Stack (2008), *Approaches to Learning: A Guide for Educators*, Buckingham: Open University Press; David Perkins (2009), *Making Learning Whole*, San Francisco: Jossey-Bass.

politically-driven debates about 'how to improve the quality of teaching and learning'.

Facilitation

Teaching does not make learning happen. Good teaching is the effective facilitation of learning. This definition of teaching comprises two facets that occur across two different time-scales. The shorter-term one concerns what one person can do to help another learn particular things. Good teaching orchestrates experience in a way that makes learning happen more reliably and more effectively. Clear explanations and prompt feedback are just two aspects of this orchestration that may or may not play a central role in any particular learning situation.

Empowerment

The second, longer-term process creates slower, more cumulative changes in broader habits and dispositions. For example, teaching someone a skill can be done in a way that leaves the learner more confident and more able to tackle 'tricky stuff' on their own (or with mates and colleagues) in the future; or it can be done in a way that has the reverse effect. The residue of good teaching, therefore, is not just an enhanced ability to do something in particular; it is a strengthened and broadened capability to pursue passions and meet challenges throughout life. The professional teacher works with learners in a way that fashions in them a resilient and adventurous spirit. They come to know better how to optimise their own learning environment; how to extract the most learning juice from their experience.

Role-taking

Teaching is a role that anyone can adopt. Teaching doesn't just happen in schools and colleges. People who teach include parents, siblings, clergy, mentors, sports coaches, theatre directors, children's TV presenters, child-minders, orchestra conductors, and any writer, gardener, chef or motor mechanic who happens to have 'students' of any kind. In a collaborative group of peers, people may switch in and out of the teaching role in a fluid and often rapid way. In some situations, as in schools, some people inhabit the teaching role (and others the learning role) on a more long-term basis. For professional teachers, the responsibility to build empowerment as well as expertise is especially clear. (The fact that we all can and do function as teachers does not mean, of course, that we all function as equally *good* teachers.)

The primacy of competence

Real-world learning involves getting better at doing things. This could include making lasagne, propagating seedlings, fixing carburettors, caring for the elderly, drawing plans, solving equations, arguing and debating, writing poems and passing exams. From this perspective, the purpose of 'understanding' is to facilitate the development of expertise. Conscious comprehension is an adjunct to competence.[3] Displays of understanding – writing journal articles, giving lectures, taking tests – are skilled performances, not different in kind from batting, cooking or acting. Studying, revising and exam-taking are crafts. How well one does in tests, therefore, reflects the mastery of those crafts rather than the size of one's 'intelligence'. And displays of knowledge do not guarantee that concomitant expertise has been developed. (People can talk knowledgeably about all kinds of things they are not very good at doing, for example)[4].

These reference points position 'school' and 'college' as a very particular kind of learning and teaching context, one that often exhibits some startling discontinuities with the world for which it is supposed to be a preparation, especially the world of work. As Professor David Perkins noted, in our interview with him for the earlier Edge report: 'One likes to say that formal education is a preparation for life, but on any reasonable criterion I think the alignment between formal education and what we do in life is very poor.'[5]

4-6-1: a working model

What follows is a 'working model' of learning in three senses. First, it is designed to help the work of thinking about how to improve education and teaching. The model draws support from current work in the learning sciences – principally neuroscience, cognitive science and sociocultural theory – but, to be useful to educators, that knowledge needs to be 'displayed' in a way that maximizes rather than obscures its utility. It needs to be well-founded in evidence, and as coherent and comprehensive as possible in scope. But it also needs to be plausible and fruitful: it needs to connect with the experienced realities of professional lives, and to offer, not sound-bites and prescriptions, but productive tools for thought that help teachers develop their practice.

To do this, a model of learning needs to be of the right 'grain', detailed enough to provide a practical

'Teaching is a role that anyone can adopt'

3. As we argued in chapter 2, there is increasing agreement amongst cognitive scientists that human beings are built for action. Our brains are designed to perceive and understand in terms of the affordances for desirable action to which they give rise. We are primarily doers, and only secondarily thinkers. See, for example, George Lakoff and Mark Johnson (1999) *Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought*, New York: Basic Books.

4. For the psychologists, 'declarative knowledge' is knowledge that can be 'declared', and declaring is a form of 'procedural knowledge' – a skilled performance – that some people have learned to be good at and others haven't. There are no 'facts' or 'propositions' stored in the brain; there are only shifting patterns of neural connectivity, the activation of some of which give rise to observable 'performances of knowledgeability or understanding'. See John Anderson (1993) *Rules of the Mind*, Hillsdale NJ: Lawrence Erlbaum.

5. David Perkins in an interview with Bill Lucas, March 2009.

grasp on complex situations, yet broad and generic enough to apply to a range of topics, goals and learners. Many existing conceptualisations of learning have proven too abstract and 'academic', or too crude, to give practitioners much help. Simply offering teachers a short menu of 'learning styles' or 'intelligences' often leaves practitioners little to do but slap a new set of labels onto learners and attempt to 'differentiate' their teaching.

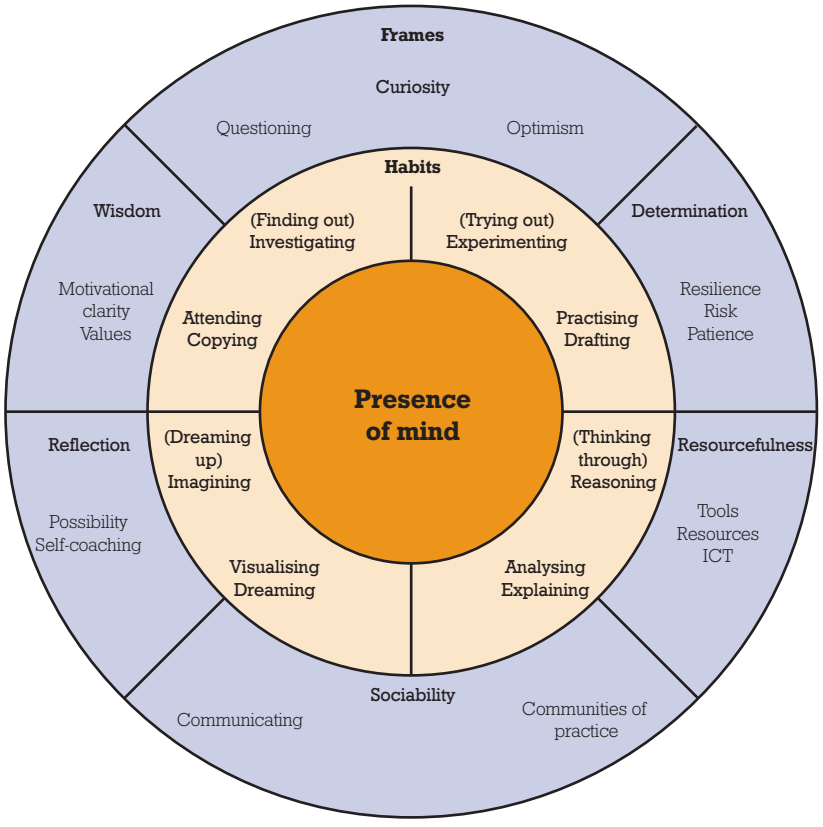
The second sense in which 4-6-1 is a working model is that it tries to capture the kinds of real-world learning that involve developing a product or a skilled performance over time. Much lifelong learning and problem-solving involve working or 'wroughting': working on the computer game, the screen-play, the recipe, the dance routine or the business plan, gradually fashioning it into something satisfying and effective. Though curriculum designers, and some teachers, have a good overview of how the curriculum progresses, deepens and 'adds up', many students, by contrast, experience lessons more as a loose concatenation of bite-size activities.[6]

Thirdly, the 4-6-1 model is itself a work in progress. It exemplifies the tension, outlined above, between trying to be an accurate and comprehensive representation of what is known about learning, and a pragmatic tool to help teachers and other educators to think about how to improve their practice. To do justice to the complexity of real-world learning, the model already has 11 different factors or elements. Some would say this is far too few to capture the richness and subtlety of 'learning in the wild'; others would contend that this is too many to conveniently hold in mind and make use of. Feedback will help to improve the utility of the model, we hope. To claim, as many previous theories have, that any model of human learning is even an approximation to 'the truth, the whole truth and nothing but the truth' is sheer hubris.[7]

6. An ex-colleague, a science educator at the London Institute of Education, once told us of her 13-year-old daughter's view of the school curriculum as a journey through unfamiliar terrain on a train with blacked-out windows. Every so often the train would stop at a station, the passengers would get out and explore, and then it would be back on the train to the next, unconnected, destination.

7. See Knud Illeris (2008) *Contemporary Theories of Learning*, London: Routledge; Chris Watkins, Eileen Carnell and Caroline Lodge (2007) *Effective Learning in Classrooms*, London: Sage.

Figure 1 **The 4-6-1 model**



Designing a practical model of practical learning

Any description of real-world learning ought to be able to operate at a number of levels.

- It should help teachers of many different kinds to think more clearly and productively about how to design learning environments that not only help learners to achieve their goals, but also build their own on-board 'learning power': their ability to maximise their own learning.
- The model should be plausible, fruitful and practical: it should be an accessible 'tool for thought'.
- It should help educational leaders to design institutions where powerful learning strategies are developed, as well as individual teachers to design effective nursery, classroom or workplace experiences.
- It should be applicable to a wide range of learning tasks and topics: those that work with concrete materials and physical skills and sensibilities, as well as those that work with symbols and arguments. Given our particular interest in PVL in this report this former point is especially important. In fact we will also continue to challenge the assumption that 'academic' learning is more sophisticated and demanding than 'practical' or 'vocational' learning.
- And it is also appropriate and desirable that such a model be couched in moderate language that invites discussion and revision.

It is against these criteria that we hope our 4-6-1 model will be judged.

In this chapter, we give a brief overview of the 4-6-1 model. Its most important features are discussed in more detail in chapters 3 and 4. As can be seen from the diagram, the model has four main regions. The 'inner' ring comprises the tools of the effective learner, arranged into four compartments. These we refer to as the learner's *habits of mind*. The 'outer' ring comprises six more general dispositions or *frames of mind* that support and direct the learner's activities. In the centre, the 'bull's eye', is the learner's *presence of mind*: the quality of mind that enables learners to mesh the resources they bring with the demands and opportunities of the present situation. Together, the four habits of mind, six frames of mind, and presence of mind, add up to a learner's *real-world intelligence*: their ability to engage effectively with the real-life challenges and opportunities which they encounter. Outside the outer ring, unlabelled on our diagram, lies the social, cultural and material context in which learners find themselves: the source of their external resources, demands and opportunities. We shall talk more about the social context of PVL in chapter 5.

Habits of mind

The four most important *habits of mind* of the effective learner are: *investigation*, *experimentation*, *imagination* and *reasoning*. These are, as we have said, the four main compartments of the learner's toolkit. Learners need to have a good range of ways of *finding out* about things; of actively *trying out* ideas and developing skills; of *dreaming up* new possibilities and creative ideas; and of carefully *thinking through* consequences and weighing up pros and cons. Within each of these compartments, some of the tools will be relatively general-purpose while others will apply more to one kind or domain of learning than to others. It is our contention –

- that both academic and practical kinds of learning draw on all four compartments, and on many of the same generic habits of mind
- that in each compartment, however, some habits of mind apply more to academic than to practical learning or *vice versa*
- but that there is no obvious difference in the cognitive complexity or level of demand between the two kinds of learning.

We hope it will become clear that there is as much to becoming an accomplished learner of carpentry or fashion design as there is to developing the learning habits of a lawyer or a university scholar.

Frames of mind

The outer ring contains what we call the six predominant attitudes or *frames of mind* that inform and support successful learning in any domain. They are general orientations towards dealing with strangeness or difficulty, and pursuing goals and interests. They comprise *curiosity*, *determination*, *resourcefulness*, *sociability*, *reflection* and *wisdom*. Curiosity makes learners proactive and inquisitive. Determination enables them to persist and be patient. Resourcefulness makes them perceptive about how to construct and convene resources that will help them learn. Sociability makes them able to contribute to, and benefit from, membership of teams and groups for learning. Reflection provides the ability to stand back and direct and guide one's own learning – to be one's own teacher or coach. And wisdom, as we use the term, refers to the clarity to select, pursue and respond to challenges that enhance personal and social well-being. This kind of wisdom enables people to direct and channel their learning in terms of their 'enlightened self-interest'. We will go into these frames of mind in more detail in chapter 4.[8]

8. Many typologies combine what we are calling habits and frames of mind into list of 'key competencies', 'wider skills', 'life skills', 'soft skills' and so on. We think it us useful to distinguish the tools of learning from the more general aspects of temperament that support their use. See Bill Lucas and Guy Claxton (2009), *Wider skills for learning: What are they, how can they be cultivated, how could they be measured and why are they important for innovation?* London: NESTA.

Presence of mind and real-world intelligence

In the middle of our model stands what we are calling presence of mind. Because it is on its own, we will take a little more time to explain what we mean by this in this chapter. In the centre is where learning happens – the present moment of engagement, where the learning person and the learning situation meet. This is when the effective learner mobilises all the appropriate resources, habits and frames of mind they possess, and few, if any of those that are inappropriate, irrelevant or distracting. Presence of mind bears a close relationship to the elusive everyday qualities of mind called 'common sense', 'gumption' and 'nous'. The nub of real-world intelligence, we suggest, lies in the optimal mobilisation of the totality of one's resources – making the best use of all one's knowledge, experience, skills and dispositions – in order to meet the demands of the moment. The demands of the external situation and present priorities are balanced and integrated in a way that generates the maximum benefit.

So real-world intelligence means not just *having* the right habits and frames of mind in your repertoire, but deploying the right ones in the right way at the right time. Presence of mind is knowing when (as well as how) to act, and when to hold back and wait and watch some more, rather than diving in. It is knowing when and how to think, and when not to. (Robert Sternberg, doyen of US intelligence researchers, has said, rather surprisingly, that 'I have come to believe that the essence of intelligence lies in knowing when to think fast and when to think slowly'.)[9]

In practical learning, the habits and frames of mind are not really individual skills, to be applied one by one, but rather instruments that weave in and out of a complex performance of learning that unfolds over time. Trying to trace the leak, start the motor, bring the dance to a satisfying climax, find the evidence you need to make your point…these are where all the strands of learning merge, and where the intuitive mastery of the expert is gradually formed. Only so much can be done to develop the habits of flexible attention and intelligent practising, for example, off-the-job, in isolation. This is one reason why we think the language of 'skills' is inadequate in the context of real-world learning: it implies too simple and too serial a model of learning. Any complex domain requires a fluid breadth and balance in the way the instruments of learning improvise and interweave together.

For example a social science PhD student and apprentice glass-blower, Erin O'Connor, describes her experience of practical learning. As she tries to produce a wine goblet (and is teased by her tutor for producing 'globlets' instead), she is experimenting and adjusting, watching and attending, imagining and wondering, evaluating and criticising, all together.[10] A rich model of practical learning, therefore, needs to describe how the four habits of mind call and reinforce each other in real time. Another famous example is provided by *Zen and the Art of Motorcycle Maintenance* author, Robert Pirsig. As he works on fixing his bike engine, he is, like Erin O'Connor, noticing and tinkering and wondering and thinking all at once.[11] Slightly romantically, Pirsig describes presence of mind thus:

Skilled mechanics and machinists have patience, care and attentiveness to what they are doing, but more than this – there's a kind of inner peace of mind that isn't contrived but results from a kind of harmony with the work…The material and the craftsman's thoughts change together in a progression of smooth, even changes until his mind is at rest at the exact instant the material is right.

Exactly the same process of internal collaboration and improvisation is typical of an academic working on a draft of a paper. In the space of five minutes she may well be playing with different ways of putting her point, dreaming up new arguments to try out, testing the strength of those arguments against the imagined voice of a critic, and searching for references in her notes or on the web.

All three – glass-blower, mechanic and scholar – are knowledgeable, and becoming more so. All are doing highly intricate crafting. All are using all four habits of mind: advanced skills of investigation, experimentation, imagination and reasoning. All are guided by the six frames of mind: urged on by their curiosity, sustained by their determination, supported by their resourcefulness, encouraged and challenged by their social contacts, enriched

'Real-world intelligence means not just *having* the right habits and frames of mind in your repertoire, but deploying the right ones in the right way at the right time'

9. Robert Sternberg (1999), The theory of successful intelligence, *Review of General Psychology*, 3, 292–316.

10. Erin O''Connor (2006) Glassblowing Tools: Extending the Body Towards Practical Knowledge and Informing a Social World, *Paper presented at the annual meeting of the American Sociological Association, Montreal Convention Center, Montreal, Quebec, Canada*, Aug 11; cited in Richard Sennett (2008) *The Craftsman*, op. cit.

11. Robert Pirsig (1974) *Zen and the Art of Motorcycle Maintenance*, London: Bodley Head. Quotation p. 296.

by their ability to stand back and reflect, and satisfied by doing something they truly consider worthwhile. All have presence of mind: they know the pleasure of intelligent absorption.

In the end, scholarship is an intricate craft, just like boat-building, fashion designing or auditing a complex set of accounts. Being a professor is a skilled job, like being a paramedic or a set designer. It is only on a very narrow view of intelligence that cabinet ministers are in any sense 'brighter' than cabinet-makers.

As Howard Gardner has extensively argued, there is really no reason why we should funnel all children, from the age of four, in the direction of professorship. Professors are expensive, and we only need so many, after all.[12] Yet conventional education seems to *want* children to become narrow and inflexible: to become mesmerised by words and reasons; to treat imagination as something childish, or only for 'creatives'; to neglect the skills and attitudes of intelligent experimentation and ingenuity; and to reduce investigation to small amounts of prescribed 'research' on the Internet. Yet Erin O'Connor's breakthrough in her attempts to produce her wine-glass came not when she read a book, and not even when she developed a new technique for blowing and twirling the pipe, but when she developed a deeper form of sustained concentration. To discover and develop that, she needed her presence of mind.

The culture and context of learning

The final element of our model embeds learners in their social, cultural and physical context. Real-world learning does not happen in isolation; it is not just a tussle between a learner and a problem. It involves other people and specific places. People make up teams, groups, classrooms, clubs, companies, communities, organisations and so forth, and 'communities of practice' establish their own ways of going about things: they develop specific cultures. What passes for normal behaviour in a hi-tech engineering factory may be quite different from what is acceptable in a well-run hotel kitchen. The way work is organised on a busy hospital ward will be different from the *modus operandi* of a modern hair-dressing salon. And so on. The importance of context and culture is so significant that we explore it in more detail in chapter 5.

Learning in the making

After this general survey of the characteristics of the powerful learner, let us come back to the core of many kinds of practical and vocational education: the crafting of material. There is something special about the thinking, doing and learning that happen whilst people are making things. And this delicate interplay between making and thinking is of particular relevance to practical and vocational education.

Many renowned scientists and inventors were makers before they were thinkers. Both Faraday and Edison learned a trade as apprentices before they went on to make their scientific breakthroughs, and Faraday was Sir Humphrey Davy's lab assistant and valet before becoming his co-researcher. Britain's iconic professor Heinz Wolff has spoken of the vital role of using his hands in the generation of the ideas, both practical and scientific, for which he is famous. 'It is important to help children to become manipulate as well as articulate', he has said.[13]

'Thinkering' is a word invented by Michael Ondaatje in his novel *The English Patient* to express the way ideas come into your mind whilst working with your hands. The processes of watching, feeling, shaping and adapting – of attentive interaction with some interesting *stuff* – seems to feed imagination and reasoning in ways that are different from, and maybe richer than, those induced by reading or listening to talk *about* stuff. Certainly they seem to have different consequences. Harvard's Jeanne Bamberger has shown that children who are good at observing and experimenting develop the ability to balance weights and build complex mobile structures, but they can't tell you what the principles are in words or formulae. Conversely many academically-inclined children can do the maths and explain the theories – but can't get their mobiles to balance.[14] As we saw earlier, abstract comprehension does not necessarily lead to practical competence.

The Illinois Institute of Technology has opened a number of 'Thinkering Spaces' for children, based on the notion that 'a child comfortable tinkering with familiar items and playing with ideas will gain the confidence and self-awareness to solve a wide variety of problems'.[15] Richard Sennett suggests that this follows through into adulthood:

'It is only on a very narrow view of intelligence that cabinet ministers are in any sense "brighter" than cabinet-makers'

12. Howard Gardner (2006) *Multiple Intelligences: New Horizons in Theory and Practice*, New York: Basic Books

13. Heinz Wolff interviewed by Jonathan Drori at the *Second International This Learning Life conference*, Bristol, June 2008.

14. Jeanne Bamberger (1991) The laboratory for making things, in Donald Schon (ed), *The Reflective Turn: Case Studies in and on Educational Practice*, New York: Teachers College Press

15. See www.thinkeringspace.org

16. Richard Sennett, op cit, p 266.

17. For a detailed description of the phenomenon of 'flow' see Mihaly Csikszentmihalyi (1998) *Finding Flow: The Psychology of Engagement with Everyday Life*, New York: Basic Books.

18. Bill Lucas, Guy Claxton and Rob Webster (2009) *Practical and Vocational Education in the UK: A health check*, Paper for Edge

The discipline required for good manual labour serves [craftsmen well], as does their focus on concrete problems… It has proved easier to retrain a plumber to become a computer programmer than to train a salesperson; the plumber has craft habit and material focus, which serve retraining. Employers often don't see this opportunity because they equate manual routine with mindless labour…But just the opposite is the case.[16]

As we argued in the previous chapter, the good news for PVE assessment is that evidence from experimental research is beginning to show that in some cases the need to explain what is learned is not only obstructive, but that it is often difficult to explain processes in which decisions and thoughts in the brain are enacted via the hands in the blink of an eye. This quick, intuitive thinkering is a feature of 'flow' – the complete immersion in a task[17]. If this is the state that somewhat defines successful learning among practically-minded young people, then repeated requests for them to articulate what they are doing, how they planned it, how they applied theory and experience to the problem, and so on, will not only slow their learning down but potentially put them off trying. A little real-world application puts this into perspective: imagine if every time you went to prepare a meal, somebody asked you to write out the recipe; you would see little point in your food being judged by what you write.

Sennett's view that practical learners are better equipped for lifelong learning is not just a selling point for PVE, but offers a potential solution to its biggest obstacle. William Richardson argues in our PVE Health Check paper for Edge[18] that the most difficult and complex curricula are not the traditional academic ones, but those that are vocationally-oriented, and that this has been a significant bar to their growth in schools and colleges. If, therefore, practical learning provides a more effective foundation for subsequent learning than does 'academic' learning, schools could capitalise more effectively on this alternative, but no less intelligent, route to excellence.

Crafting

Many vocations involve crafting: horticulture, motor mechanics, hairdressing, plumbing, installing electrical circuits and designing fabrics, to name just a few. So what goes to make up the kind of learning and progression that occur in the context of making? (We are not claiming that the following features are unique to the world of such practical crafting; only that they seem to be important elements of it.)

Engagement

Working with physical material seems to invite intense absorption. At a neural level that may partly be because there are a lot of different sensory, motor and cognitive events occurring that correlate in complex ways. The plane feels a certain way as it moves over the wood. The wood looks and feels a certain way. There are knots and grains that need to be noticed and accommodated. And the look of the shaving that is produced is a complex reflection of the grain, the type and condition of the wood, and the pressure, angle and smoothness of the pressure on the plane. There is the smell of sawdust, the 'shoosh' of the plane as it moves, and the occasional sharp pain of a splinter. In the kitchen, the selection and quantity of the herb results in a change in smell and taste.

Though this is not an intellectual process, and what is going on may be hard to articulate, nevertheless a good deal of the brain's processing capacity may be required to keep track of and distil out these correlations. In some sports, for example, this intensity of concentration may be required by the speed at which events are occurring, and the need to respond quickly. In the manual crafts, speed may not be the issue; it is more the delicate interweaving of complex patterns of sensation and action that create the demands on cognition. And sensitivity to those complexities may be both cause and effect of the state of absorption. The more attentive one is, the more those contingencies reveal themselves; and the more sensitive one is to the patterns, the stronger the sense of being engrossed in the activity.

By contrast, words, numbers and symbols constitute, for many people, only an experience-thin medium that has much weaker attention-grabbing power. Early in his career, Seymour Papert, later to become co-founder of the world renowned MIT Robotics Lab, worked as a mathematics education researcher in a Junior High school in Massachusetts. To get to the maths classrooms, he had to go past the art room.

For a while I dropped in periodically to watch students working on soap sculptures, and mused

'Many renowned scientists and inventors were makers before they were thinkers'

about ways in which this was not like a math class…What each student carved came from wherever fancy is bred, and the project was not done and dropped, but continued for many weeks. It allowed time to think, to dream, to gaze, to get a new idea and try it and drop it or persist, time to talk, to see other people's work and their reaction to yours – not unlike mathematics as it is for the mathematician, but quite unlike math as it is in junior high school.[19]

Edith Ackerman and colleagues comment on the story from which this excerpt comes: 'Papert noticed that when students were making something with their hands (such as soap sculptures), they were in a deeply engaged state, whereas when they were making something rather abstract in their minds alone (such as solutions to maths problems) they were much less engrossed.'[20] Papert puts his finger on several of the elements of mental activity which we explore below.

Teachers are compelled to make their lessons engaging, but to do so in an 'elusive quest for a boredom-free classroom'[21] is to overlook other important structures that go beyond pedagogy. For example, timetables that allow students to tackle problems over a day, a week or a month are more likely to improve the prospect of deep engagement than the 50–60 minute lessons that are typically the norm.

Pride

Getting something to 'work' is often intensely satisfying. But what 'work' means is a complex notion. Making a model airplane that actually flies, nurturing a cutting that actually propagates, producing a hollandaise sauce that is silky and glossy just like in the picture: getting it to 'work' is partly signalled by direct physical feedback from the material itself. But pride also comes from a sense of aesthetic or creative accomplishment: it *feels* right, it captures the hard-to-articulate hope or intention behind the work. That feeling of satisfaction that you can't put into words – 'Yes, that's it!', as opposed to 'Mmmm, that's not quite it' – is often an important accompaniment of practical learning. Pride can come from financial reward – people actually paid for the meal, the watercolour or the haircut I produced. That tangible sense that your product is worth paying for is often intense. And finally, there is also the pride that comes from recognition and appreciation by other people, especially those whose opinion matters to you, and/or who are recognised arbiters of quality in the field. The sources of pride – which matter most – often change as levels of skill, complexity and accomplishment increase. Keeping clear about this shifting balance can be complicated.

Tutors and mentors have many opportunities to help their students develop and value this sense of 'pride in a job well done'. It can be very different from 'getting good marks', which can signal the ability to pass tests, and gain qualifications, but which may neglect the intrinsic satisfaction of accomplishment. Conversations between tutors and students that develop pride are more likely to be genuine conversations about how best to tackle a tricky problem, than ticks in boxes that show that 'standards' have been met. And tutors' role is also to coach their students into the habit of self-evaluation – of learning to be their own evaluator – helping them to become independent learners and confident appraisers of their own work; helping them to develop a sense of 'it's going well' or 'this doesn't feel right' – what we call in chapter 4 'the coach in your head'. The 'assessment for learning' (AfL) techniques that are common in schools these days ought to contribute to the development of pride and reflection, but sadly sometimes amount to little more than training students in how to 'narrow the gap' between their current performance and that needed to pass tests.[22]

Decision-making

There are always options and uncertainties to be resolved; and the resolution can be to 'play it safe' or to 'try it out'. Which route you take depends on many factors including memory, confidence, time pressure and the cost of failure. (I'm happy to take a chance with the family dinner, but not with an important dinner party. And I certainly don't want my electrician getting too creative…) Some decisions are high-level; others more operational. The fineness of the dice affects the cooking time, as does the medium the vegetables are going to cook in. Potatoes always seem to take longer to cook in a stew than in boiling water, so either I parboil them first or I have to cut them smaller… The selection of tools is important: which whisk, saucepan, screwdriver or type of compost do I use for *this* job?

'Timetables that allow students to tackle problems over a day, a week or a month are more likely to improve the prospect of deep engagement than 50–60 minute lessons'

19. Seymour Papert and Idit Harel (1991) *Constructionism*, Norwood: Ablex Publishing

20. Edith Ackermann, David Gauntlett and Cecilia Weckstrom, (2009) *Defining Systematic Creativity*, LEGO Learning Institute

21. Frank Furedi (2009) Make children embrace boredom, published in *the Times Educational Supplement* on 6 November

22. Bethan Marshall and Mary Jane Drummond (2006) How teachers engage with Assessment for Learning: lessons from the classroom, *Research Papers in Education*, 21(2), 133–149.

As the routine operations of a craft are stabilised and automated, so the four habits of mind – observation, experimentation, imagination and reasoning – each get to play at higher levels. Observation is no longer tied to making sure you've 'got it right', and is freed up to attend more to the balance of flavours or the visual interplay between rough and smooth texturing of the stone. Experimentation no longer needs to focus on the precision of skills, and can afford to become a little more adventurous. Thinking need not be so tight and self-critical, and can work more closely with imagination to blend knowledge and reading into a richer set of options. As the mind and body relax, secure in their joint competence, so decision-making can become more contemplative, refined – and sometimes bold.

PVE then is clearly conducive to helping young people develop autonomy, from safe classroom environments where they can experiment and observe the outcomes of different decisions, to the workplace settings where they can 'do it for real', as confidence builds and students hone their skills.

Sketching and pondering

In many types of craft, the role of transitional or provisional sketches, drafts, maquettes and models seems to be important. Often the partly completed work is its own 'draft', but sometimes a sketch or a model seems to be needed. Having a stable, tangible object that you can contemplate and ponder on seems to allow important kinds of thinking and imagining. In other kinds of learning, there may be no object that can 'freeze' your progress, and allow that kind of off-line reflection. (Music, dance and sports don't produce objects in the same way as sculpture and dressmaking does, though you can make recordings that can then be mulled over in a somewhat similar way.)

Crafters can create provisional products in their imaginations, of course, but many people possess only a limited ability to manipulate images in their mind's eye, and are more able to explore interpretations and possibilities when contemplating a physical sketch.[23] Studies have shown that people find it much harder to 'see' the alternative interpretation of an ambiguous figure in imagination than when they are looking at the real picture, for example. Artists often employ this sketching – pondering – re-sketching process to build up layers of interpretation in their work – levels of complexity that imagination alone would not have been able to reveal to them. Practical activities thus afford a particular kind of compound learning, which involves the interplay of attending, investigating, experimenting, practising, imagining, thinking, decision-making and pondering. For many experienced crafters and artisans, this kind of complex learning process has become second nature – one reason, perhaps, why its complexity has not often been made explicit, and has thus been underestimated.[24]

Sennett argues that the thinking that arises from this cyclical process benefits from the real physicality of the sketching process. Architects can produce beautiful images using computer-assisted design (CAD) packages – but too much reliance on the computer leads to less careful thinking and imagining on the part of the architect. There are nuances that CAD will miss, and that the designer will gloss over if they are not careful. There are discoveries and possibilities that will not show up in the fast reorganisations on the screen, which might have surfaced during the more intimate and leisurely process of sketching and drawing.[25]

This last point might give pause for thought on the role of ICT in PVE. Software tools are surely going to become ever more prevalent and sophisticated, but learners will need to guard against becoming dependent on these tools, and teachers will need to encourage students to do the additional thinking that compensates for the limitations of CAD and other systems. Software systems can quickly become dated: they are created according to a specific set of rules and criteria that are assumed to be correct at one point in time. PVE practitioners must look for ways to encourage students to use automated design tools as part of a wider process over which they, not the computer, are the chief architect.

Explicit knowledge

Being able to talk about vocational activities is secondary to being able to do them. As we saw earlier, in PVE, competence has priority over articulation. That is not to say that being knowledgeable, and being able to construct explicit descriptions and explanations, is of no value: far from it. But the display of knowledge is not for its own sake. People who do not 'get' reading for pleasure may nevertheless learn to read better for a practical purpose. They may

'The sense of "pride in a job well done" can be very different from "getting good marks"'

23. Mozart was, perhaps, an exception. His apparent ability to produce 'final drafts' of his music without corrections belied the mental ability to go over his scores again and again in his mind before setting them down. The inventor Nicolai Tesla was another. His imagination was so exact, sustainable and well-informed that he claimed to be able to discover potential flaws in his inventions by 'running them in his mind', and rarely needed to check his findings by building physical prototypes.

24. Deborah Chambers and Daniel Reisberg (1985) Can mental images be ambiguous?, *Journal of Experimental Psychology: Human Perception and Performance*, 2(3), 317–328; Cees van Leeuwen et al (1999) Common unconscious dynamics underlie common conscious effects: a case study in the interactive nature of perception and creation, in J.S. Jordan (ed), *Modelling Consciousness across the Disciplines*, Lanhan MD: University Press of America

25. Richard Sennett, op cit., p 41.

be drawn to improve their literacy in the service of getting better at their craft. They will read a technical manual or chat online with fellow crafters, even though their levels of accredited literacy might be quite low.

Also, conscious thinking is intermittent in manual learning, and the state of attentive non-thinking that can prevail for periods of time is conducive to the development of subtle expertise. The research shows that thinking about what we are doing is only necessary or even helpful *some* of the time; it interferes if we do it too much. We can make much finer discriminations in perception than we can in words, so the attempt to explain or describe what we are doing can coarsen our attention, and thus our learning. It is not an inconvenience of practical and vocational learning that people can often not articulate what they are doing or why; it is absolutely of the essence.

Discussion
Knowing technical terms enables you to communicate more effectively with others in the field and thus learn more from them, and ask better questions. In many fields of practical expertise, practitioners learn more from such informal conversations with (more knowledgeable and experienced) peers than they do from formal tuition or from written materials. Having access to these networks of fellow-enthusiasts is therefore important for learning (though people differ, and there will be some who prefer sitting quietly in the library, or browsing online, to joining a chat-room or a club).

The stability of the sketch or the evolving product, as Papert noted, also allows it to function as a talking point. One can wonder aloud about its development in the company of other people, especially peers whose opinion one values and whose judgement one trusts. In an art college, a communal kitchen or a cooperative workshop, for example, the public production of work by a group of people allows conversation and observation to stimulate all kinds of thoughts and possibilities. People are trying out new techniques, discovering new affordances of the media in which they are working, and sharing their findings.

The more trust and fellowship there is, the more honest, open and creative such conversations can be. The more friendly competition there is, the more people can be stimulated to push themselves into more novel and more skilful endeavours. When both trust and competition are high, and the latter does not damage the former, such a group of people can bootstrap their skill and their ingenuity, and produce work of outstanding quality. (The firm Motorola created what it called the 'technology shelf' – a kind of physical notice board on which groups of engineers would place technical inventions that they thought might be of use to others in the future, or to teams working on different problems.)

Teachers can support the development of open and creative conversations in colleges and work-places by sharing thoughts and physical drafts of work they themselves are engaged with. For example, a science teacher might talk to an on-going experiment set up in the corner of the lab; a design and technology teacher might talk students through a DIY project at home; or an English teacher might share annotated drafts of a short story. FE tutors and work-place mentors usually have ample opportunities to externalise their own thinking and learning processes in the company of their students and trainees. All of these examples provoke discussion and demonstrate the learning in the lives of everyday people.

Instruction and imitation
As we saw earlier, physical learning is greatly boosted by observing people doing it better than you can, and trying to imitate them. 'Watch me… now try it yourself'. This process on its own, however, is not always so effective. 'Yes, I can see what you did, but how did you do it?' complains the novice retail manager or plumber.

So although language cannot capture the nuances of skill either, it helps if your instructor talks about what they are doing, as well as does it. And it helps even more if the instructor's explanations and instructions are based on an empathic appreciation of where the learner is – what he or she is likely to find difficult, and the common errors that people at that stage of learning tend to make. That's why a senior student, someone just a bit better than you, can be a better guide than the 'master', who may have quite forgotten what it was like to be a beginner. Written and pictorial instructions, for putting together self-assembly furniture, for example, tend to be produced by people who have performed the operations thousands of times, and

'Research shows that thinking about what we are doing is only necessary or even helpful some of the time'

may be useless to someone who can't remember the last time they held a screwdriver.

There is plenty of scope here for schools to engage older pupils to support and share learning stories with younger peers. Pupils have the advantage of being outside of the system, with no overt interest in ensuring that tasks are completed come what may, plus there is much less of a power differential between students. Many older pupils will be fresh from situations where they struggled; where somebody afforded them the time and patience to help them with the hard parts. Passing on techniques in non-judgemental ways in non-threatening contexts will appeal to younger learners. Furthermore, there is a much more advantageous student-to-student ratio than teacher-to-pupil ratio in any college.

Creating and customising tools

As physical skill in the use of standard tools develops, so they may reveal their limitations – and the crafter is then challenged either to improvise, and use the tools in increasingly non-standard ways; or to invent new tools that do the job better. Making your own dibber out of an old spade handle, or bending the blade of a small knife to do a particular boning job, become part of the consciousness, and the pleasure, of the skilled crafter. Their dexterity and the range of tools they use develop together, not just incrementally shaping and challenging each other, but demanding new heights of invention as well.

Conclusions to Chapter 2

Cumulatively, several lines of research have shown that learning to do skilful things with one's hands is no less complex than learning to do skilful things with speech and writing. Unpacked, and looked at properly, Practical and Vocational Learning is every bit as worthy of our full admiration as the Academic Learning with which it so often, and so falsely, contrasted. In this chapter we have given an overview of a model of practical learning, the 4-6-1 model – that we think does the requisite justice to the subtleties of practical learning. We have focused, in the last part of the chapter, on the special kinds of learning that happen when one is working with tangible material. We hope we have demonstrated that these subtleties are real and not merely rhetorical. Any vocation involves so much more than the routine rolling out of mechanical skills.

In this chapter we have also begun to show what some of the implications of this model might be for the design and delivery of practical and vocational education. Tutors might help trainees develop the languages in which to think about and notice their own learning more effectively. They might make greater use of modelling between more and less experienced practitioners, capitalising more on the learning that can go on between different cohorts of apprentices. They might orchestrate learning activities so that there is a good deal of thinking woven into the doing, and more doing woven into the thinking, so that the mental and the manual sides of learning develop in a more integrated fashion. They might construct activities that do not just develop skill, but also cultivate habits of self-evaluation, and also the feelings of pride and accomplishment that can motivate further learning.

In the next chapter we take a closer look at the four habits of the learning mind, and in chapter 4 we explore the value of the six frames of mind. In each case, we shall highlight the research base that underpins these facets of the learning mind.

'Learning to do skilful things with one's hands is no less complex than learning to do skilful things with speech and writing'

Chapter 3
Habits of mind

Many people have the capacity to make thoughtful decisions, but they aren't motivated to do so. Many people know how to pose problems and ask questions but frequently they don't see the purpose in it … Abilities alone are dry and dormant. Passions, motivation, sensitivities and values all play a role in bringing intelligent behaviour alive.
Shari Tishman[1]

Learning is a craft. Recent advances in the scientific research on learning has demonstrated just how much of our learning capability depends on the tactics, strategies, habits, inclinations, values and beliefs we have picked up through experience. Extracting learning from a mixture of tuition and experience is something that everyone can get better at. To give just two quick illustrations, pianists progress faster if they have learned the knack of picking out and practising the 'hard parts', and then re-inserting them back into the whole piece, rather than flogging straight through time and again. At a more attitudinal level, people who believe that 'If you don't get it quickly, you'll never get it' – as a good many students do – are less resilient and ingenious in the face of difficulty.[2] There may be some innate variation in people's ability to learn, but it is much less significant than is usually thought. The scientific spirit of the times is better caught in the title of a seminal work by Harvard's David Perkins: *Outsmarting IQ: The Emerging Science of Learnable Intelligence*.[3]

Some of these learned learning abilities are specific to particular domains. Clearly the problem-solving strategies of an apprentice carer are different from those of an electrician. But it appears that there are many aspects of learning 'gumption' that are more generic. It is to these that we now turn our attention. We contend that it is a core purpose of education, at school, college and workplace, to guide students and apprentices towards the development of learning-positive (or 'pro-learning') habits and frames of mind.

The learning sciences have shown that it matters what we call these generic aspects of people's 'learning power'. Most commonly they are called 'skills' or 'competencies' – 'personal learning and thinking skills' in the National Curriculum; 'key skills', 'soft skills' and 'wider skills' elsewhere. The RSA's Opening Minds initiative lays out a 'competency'-based curriculum. The New Zealand national curriculum is built around the development of five 'key competencies', and so on. There is a problem with the notion of 'skills', however, that is alluded to in the quotation from Shari Tishman above. People may possess skills, but lack the awareness of when and how to make use of them in complex, real-life situations. If the situation prompts you sharply when a skill is appropriate – as it usually does in school – this lack of internal 'sensitivity to occasion', as Tishman calls it, may not matter. But in real life, you cannot rely on someone popping up and saying: 'Now remember: this is the time to make use of those good thinking skills we taught you'. That is why the recent tendency in the learning sciences is to speak more of 'learning dispositions'[4] or 'habits of mind'.[5] In this chapter, where we lay out a view of the generic tools for learning that are essential in PVL, we will tend to use the latter phrase, while in chapter 5, when we go on to focus on the more general attitudes that support powerful learning, we will refer to 'frames of mind'.

The four general habits of mind which we have identified are applicable to both intellectual and practical kinds of learning. As we have said, we think it is important, if we are to regain a genuine parity of esteem between practical and scholarly kinds of learning, to be able to describe both of them in the same language. In both, the skills of *investigation* are clearly vital. Learning requires an openness to new information, and the inclination to seek it out, and evaluate it intelligently.

1. Shari Tishman (2000) *Why teach habits of mind*, in Art Costa and Bena Kallick (eds), (2000) *Discovering and Exploring Habits of Mind*, Alexandra VA: Association for Curriculum Development and Supervision.
2. This research is reviewed in Guy Claxton (1999), *Wise Up: The Challenge of Lifelong Learning*, London and New York: Bloomsbury; and David Perkins (2009), *Making Learning Whole*, San Francisco: Jossey-Bass.
3. David Perkins (1995), *Outsmarting IQ: The Emerging Science of Learnable Intelligence*, New York: The Free Press. See also Anders Ericsson & Neil Charness (1994) Expert performance: its structure and acquisition, *American Psychologist*, 49(8), 725–747
4. e.g. Ron Ritchhart (2002) *Intellectual Character: What It Is, How To Get It and Why It Matters*, San Francisco: Jossey-Bass
5. 'Habits of mind' is the phrase used by philosopher John Dewey (1933) in *How we think: A restatement of the relation of reflective thinking to the education process*. New York: D.C. Heath, and more recently taken up and developed by Art Costa and Bena Kallick. See Art Costa and Bena Kallick (2000) *Discovering and Exploring Habits of Mind*, Alexandra VA: Association for Curriculum Development and Supervision.

Scholars may do this largely by reading books, attending seminars, and searching databases. Weavers in traditional societies may get most of their information by careful watching of more skilful others, and by attentively noticing how different kinds of yarn feel and behave. Apprentices in the construction industry will need some of both of these. Both need the skills and dispositions of *experimentation*: scholars develop multiple drafts of an argument; craftsmen evolve their designs and recipes, and practise the skills of their trade over and over. Both need *imagination*: the ability to sense new possibilities and solutions. And both have equal need of *reasoning*: the ability to analyse their progress and their results, to work out the consequences of their actions, and to construct models and explanations. There is abundant evidence from the learning sciences that these four general habits of mind are essential to powerful learning.[6]

The four habits of mind

We now look at each of the four main habits of mind in turn, and illustrate their basis in recent research. As we do so, though, it is important to remember that, in action, they do not function alone or in a neat sequence, but weave together in intricate and ever-changing ways. If we look at each habit as an instrument, we should think of them as instruments in a jazz ensemble, not playing in isolation, but interacting and responding to each other, and to the shifting energies and responses in the audience.

Investigation

Effective real-world learners need to be good at finding out. They are good at seeking and gathering information. They are enthusiastic researchers. That can mean reading and thinking and note-taking; but it can also mean just attending carefully and mindfully to situations, taking their time if needs be, not jumping to conclusions, letting the situation 'speak to them'. They know how to concentrate; they can easily get lost in their observations and inquiries. They like and are good at sifting and evaluating what they see and hear and read: they develop a trust in their ability to tell good evidence from weak. And they are especially keen on observing how other people go about things, knowing them to be invaluable sources of hints and clues about what to try. There is no reason to think this is not equally true of actors, skateboarders, philosophers and poets.

The platform for investigation is, of course, attention – something about which much has been learned in the last decade. Attention means locking on to sources of information and being receptively engaged with that information. One of the brain's major functions is the control and modulation of attention. We can not only vary what we are attending to, but *how* we are attending. For example, we can be looking *at*, or we can be looking *for*.[7] Sometimes it is the former – what psychologists call *bottom-up* processing – that works best, when we want to see the situation 'as it is', devoid, as far as possible, of our own preconceptions and expectations. (We need to know when and how to let experience challenge our beliefs). And sometimes it is more efficient to do *top-down* processing, and let our hypotheses and ideas drive the looking. The ways in which the brain modulates and controls its own modes of attention have been recently investigated in some detail by neuroscientists such as Stephen Grossberg and others.[8]

A good doctor, pilot or motor mechanic has to balance these two ways of looking, so they are using their knowledge, but do not let it blind them to the unusual or the unexpected. The mechanic, faced with an engine rattle, is alert both to the menu of possibilities stored in her brain, and also to the unique and unfamiliar aspects of *this* rattle, which is not quite like any other. The skilled passer of written examinations does the same kind of thing. The constant exhortation to 'read the question' is a warning not just to deliver the prepared answer that you think (or hope) is the one wanted, but to attend to the detail of what is on the exam paper, and be ready to customise your knowledge in the light of what you see. Expert learners are able to balance top-down and bottom-up attention in fluid and dynamic ways. They know the difference between seeing and looking, hearing and listening, smelling and sniffing, tasting and savouring, touching and feeling. They can use attention as a floodlight, or as a laser. They can look for details, or let patterns and shapes emerge.[9] Sometimes the doctor will be interested in the quality of the pain in your left knee, and sometimes she will ask you if there is 'anything else

'Effective real-world learners need to be good at finding out. There is no reason to think this is not equally true of actors, skateboarders, philosophers and poets.'

6. See Guy Claxton (1999) *Wise Up: The Challenge of Lifelong Learning*, London and New York: Bloomsbury; Ellen Langer (1997) *The Power of Mindful Learning*, Reading MA: Addison-Wesley; Peter Vaill (1996) *Learning as a Way of Being*, San Francisco: Jossey-Bass

7. We'll talk mostly of 'looking', 'seeing' and so on, but we could equally talk of listening, feeling, tasting and sniffing, of course.

8. Stephen Grossberg (2005) Linking attention to learning, expectation, competition and consciousness. In L. Itti , G. Rees, and J. Tsotsos (eds.), *Neurobiology of attention,* San Diego: Elsevier, 652–662.

9. Looking intently *for* the hidden 3D pattern in a 'magic eye' picture stops it emerging. You have to gaze *through* the scene, and then, if you are lucky, the brain brings the 3D image into focus. The knack of seeing these images is learnable – like all the other forms of attention.

on your mind', perhaps because you seem a little 'off-colour'.

Attention can be *verbal or non-verbal*.[10] You can pay attention just to what is being said, or you can be sensitive to the way the voice trails off as if lacking conviction in its own story – or both. Some people are habitually more attuned to one than the other. Counsellors and psychotherapists have to learn to attend to both. Attention can be *oriented outward or inward* – or both. You can be looking at a picture in a gallery with admiration of its composition and technique. Or your eyes can be on it, but you are lost in some inner concerns that have nothing apparently to do with the image before you. Or your inner experience and imagination can be resonating with the image, so that you are simultaneously aware of the picture, but also aware of what is being stirred, touched or moved in you at the same time.[11] You can be looking at a head of hair as an opportunity to try out the new style you recently saw in a magazine; or you can be attending to the whole person, noticing their face, their energy, the way they are dressed, their age, what they say they might like….and then allowing an idea to emerge and be shaped in discussion. The haircut your client ends up with will be not just a reflection of their desire and your skill, but also of the quality and direction of your attention.

Attention can be *sustained or scattered*. Sometimes it is good – if you are in dangerous territory, for example – to lock only lightly onto the scene in front of you, and to be highly receptive to slight shifts in sight, sound or smell that might intrude. Distractibility is sometimes functional (and children who have grown up in chaotic or perilous homes may have learned vital, intelligent strategies for 'light-attending' that may later in school be labelled 'attention deficit disorder'). But when it is safe, it is also valuable to be able to become impervious to distraction. Elite athletes and performers have learned how to do this, and how to repair their concentration fast if it is disrupted at the wrong moment. They know the kinds of rituals, and the kinds of self-talk, that will enable them to regain their focus. [12]

Not quite the same thing, attention can be *absorbed or distanced*. Sometimes one is completely immersed in a task, in the state psychologists[13] call 'flow' and athletes refer as being 'in the zone'. Other times, one can be concentrating, but with a degree of ironic detachment or distance from the task that allows for a slightly more sceptical or disengaged attitude towards it. And yet again attention can be *credulous or sceptical*, according to whether one has one's critical antennae primed and looking for faults or failings, or whether one is inclined to accept impressions and information at face value. Research has found that these two modes, the credulous and the sceptical, are associated with different moods or emotions. A tinge of anger or irritation makes one attend in a more critical and meticulous way, while cheerfulness makes one more creative, but also more gullible.[14]

As we have already indicated, people build on these basic attentional habits of mind in different ways for different domains. Traditional education tends to reinforce habits of investigation that are explicit and organised – researching, note-taking, information-organising and so on. Writing an essay requires the ability to organise a mass of information that is not yet 'second nature'. But a young fitness trainer will be studying in a different way, probably through paying more careful non-verbal attention to the behaviour of admired colleagues or continually replaying DVDs of respected experts. Football coaches will draw on recent research on the training of attention to develop a kind of dual attention in their players, in which acute peripheral vision is balanced by intense focal concentration – not an easy trick to learn, but one which has been shown to develop with experience.[15]

Sustained observation of role models is a powerful learning medium for children (and, indeed, for adults). Neuroscientists have recently discovered cells in the brain that are built specifically for imitation.[16] And imitation has been shown to be one of the most important methods of childhood learning there is.[17] Children are born mimics. But habits of imitation are significantly influenced by early experience. In some more traditional communities such as Mayan villages in rural Mexico, children become highly adept at watching and learning from both adults and other children. Instructed to 'wait their turn' while an adult demonstrates a trick to another child, Mayan three-year-olds watch the demonstration with great intensity and later show evidence of highly effective learning. American children in Utah, however,

'Sustained observation of role models is a powerful learning medium for children (and, indeed, for adults)'

10. Bertram Ploog, Snigdha Banerjee and Patricia Brooks (2009), Attention to prosody (intonation) and content in children with autism and in typical children using spoken sentences in a computer game, *Research in Autism Spectrum Disorders*, 3(3), 743–58.

11. Anne McCrary Sullivan (2000) On the art and science of attention, *Harvard Educational Review*, 70(2), 211–217

12. Maurizio Bertollo, Beatrice Saltarelli and Claudio Robazza (2009) Mental preparation strategies of elite modern pentathletes, *Psychology of Sport and Exercise*, 10, 244–254; John Sutton (2007) Batting, habit and memory: the embodied mind and the nature of skill, *Sport in Society*, 10(5), 763–786

13. Mihaly Csikszentmihalyi (1998) *Finding Flow: The Psychology of Engagement with Everyday Life*, New York: Basic Books

14. Joseph Forgas, Liz Goldenberg and Christian Unkelbach (2009), Can bad weather improve your memory? An unobtrusive field study of natural mood effects on real-life memory, *Journal of Experimental Social Psychology*, 45, 254–57.

15. Soichi Ando, Noriyuki Kida & Shingo Oda (2001) Central and peripheral visual reaction time of soccer players and non-athletes, *Perceptual and Motor Skills*, 92, 786–794; Nikolas Vlissides (2007) Peripheral visual response times of expert and novice football players, unpublished undergraduate research project, University of Leeds.

16. For a summary, see Susan Hurley and Nick Chater (eds) (2005) *Perspectives on Imitation: From Neuroscience to Social Science, Vol. 1, Mechanisms of Imitation and Imitation in Animals, and Vol. 2, Imitation, Human Development and Culture*, Cambridge MA: MIT Press

17. Michael Tomasello (1999) *The Cultural Origins of Human Cognition*, Cambridge MA: Harvard University Press

become irritable and often disruptive under the same conditions, and later show no evidence of vicarious learning. It has been suggested that parents' and teachers' own habits of attention are highly contagious for the children in their vicinity – for good or ill.[18] There are also concerns that digital culture is making young people highly skilled at fleeting and superficial forms of attention, but at the expense of their ability to sustain engagement with more demanding situations.[19] All of this research has clear implications for the design of PVE.

Experimentation

The twin of investigation is experimentation: having a go and trying things out. As we noted above, observation tends to be a relatively passive or ineffective learning mode without its twin to guide and constrain it. Observation and investigation become focused and selective in the context of trying to get something done. Investigation and experimentation together are what Jean Piaget called *sensorimotor* learning[20], and Jerome Bruner *enactive* learning[21]. They tend to get bundled together – in Piaget's case literally, in a compound adjective – because, by default, they always occur together.

In experimentation, people learn by adjusting things, tuning their skills, and looking for small improvements. They enjoy reviewing their 'work in progress' – a planting scheme, a menu, a composition – and seeing how they can redraft and revise it. They know how to make good use of drafts and sketches. For a musician, this might be a recording of their own rehearsal that they can go back and listen to, in order to pick out both the 'good bits', to be retained and built upon, and the 'hard bits' that are going to need further practice.[22] For a horticultural student it might be a series of digital photos of a garden at different seasons, to be mulled over during the winter months as a stimulus to the new season's planting. Not only do such sketches allow communication with others (who may be on the other side of the world); they freeze one's own learning in a visible or tangible way, thus allowing you to think more slowly about them. Sketches afford different kinds of learning from those that happen 'on the hoof'.

Experimentation almost always involves practice, so let us illustrate the degree of sophistication that is possible when thinking about learning-to-learn by unpacking the notion of practice in more detail. Skilled learners know how to do 'good practice': how to extract the most learning from their experience. There are individual differences between the practising habits of concert pianists, or of elite swimmers, but they have all put energy into discovering what the most powerful methods of practising are for them. And what they and their coaches have discovered may well offer useful suggestions to the young apprentice carpenter or carer as well. Recent research confirms that there is no substitute for 'putting in the hours'. Intellectual understanding does not short-cut the learning that accrues from practice and experience. But 'putting in the hours' is inefficient if the practising is not deliberately aimed at extending expertise. Practice needs to be designed explicitly to have focused goals and targets that challenge and stretch current levels of skill. There is a good deal of research in areas such as sports psychology, and the learning of musical skill, that has potential relevance to the design of PVE.[23]

It is useful to distinguish five kinds of practice. First, there is 'getting the feel'. Every time you try something new, you feel awkward. Your first haircut, first hollandaise sauce, first go at wiring a fuse-board, first attempt at getting a confused old lady to the toilet: they were all clumsy. Your body simply didn't know how to put its muscles together in the right way. And it didn't yet have a template for how it *ought* to feel when it was done well. These templates take time to develop through practice, and *you can't be told how to do it or what it should feel like*. You have to 'get the hang of it'. And one day, you will, often more by luck than judgement, do it passably well, and your body begins to construct the template that it can use to guide its own development. This is the most uncontrollable stage of practice, and people will begin to 'get it' at different times. Feeling safe to watch others and have a go when you feel ready will speed learning up. (Skilful young learners often know that it is smart to invest time in this preliminary observation: their brains become ready to make that motor template faster). Being laughed at, made to feel 'slow', or pushed into having a go before you are ready, can retard learning in the long run.[24]

Second, there is practice that is aimed at 'automating'. Having got the feel of something, it takes a lot longer to get to the point where the skill comes so reliably and smoothly that you don't have to think about it. Psychologists talk about the kind

'Intellectual understanding does not short-cut the learning that accrues from practice and experience'

18. Barbara Rogoff (2003) *The Cultural Nature of Human Development*, Oxford: Oxford University Press.
19. Maggie Jackson (2008) *Distracted: The Erosion of Attention and the Coming Dark Age*, New York: Prometheus
20. Jean Piaget (2001) *The Language and Thought of the Child*, London: Routledge
21. Jerome Bruner (2009) *Beyond the Information Given*, London: Routledge
22. Lucy Green (2002) *How Popular Musicians Learn*, Aldershot: Ashgate
23. Anders Ericsson (2002) Attaining excellence through deliberate practice: insights from the study of expert performance, in Michel Ferrari (ed), *The Pursuit of Excellence through Education*, Mahwah NJ: Lawrence Erlbaum; Harold Jorgensen and Susan Hallam (2009) Practising, in Susan Hallam, Ian Cross and Michael Thaut (eds) *The Oxford Handbook of Psychology in Music*, Oxford: Oxford University Press
24. See Barbara Rogoff, op. cit. Also Albert Bandura (2009) Social cognitive theory goes global, *The Psychologist*, 22(6), 504–6.

of learning that turns 'conscious competence' into 'unconscious competence', and it is the latter that a skilled bricklayer or sous-chef will need. A tutor at the London Royal College of Music recalls a senior student who, in the advanced stages of preparing a piece for performance, would play it through again and again whilst reading a book propped on the music stand[25]. Such learning needs time and repetition to get into your brain, hands and feet, so you do the right thing even when there is not time to think. There is no substitute here for just doing it over and over again. The vital ingredients are time, determination and attention[26].

Third, as we have already noted, there may well be a phase of practice called 'picking out the hard parts'. Your sauce keeps going lumpy, or your weld keeps being too brittle. In this kind of practice, you need to identify what it is that needs work, unpick it and work on it. It's helpful if your coach or tutor helps learners learn how to do this identifying for themselves, and doesn't always tell them what it is they need to do. Then they can build up the habit of mind called 'self-evaluating', which we talk more about below. It's a crucial part of 'practising the hard parts' that, once you have worked on them in isolation, you put them back into context, so they become part of the bigger picture. This process of 're-embedding' takes time and experience. It doesn't just happen by itself. It is false psychology to think it should.[27]

The fourth kind of practice is called 'improvising', and it can often be woven in to the earlier kinds. If all your practice is aimed at becoming more efficient and automated, it shouldn't surprise you if your skill starts to become robotic – very smooth in carrying out well-practised routines but lacking creativity, and unable to adjust when things get trickier.

Variegated practice brings the flexibility and playfulness back in[28]. Your tutor might say: 'I know you can now do it pretty well…now I want you to mess it up and see what happens if you do it a bit differently. Don't worry if your control dips for a while – you'll soon get it back. But making practice more variegated will build in the flexibility to respond to new situations, and your skill will therefore be more adaptable and robust'. Interspersing the hard work and competitiveness with this kind of licensed playfulness is good for motivation too. Effective learners should be happy to try it different ways, to mess it up, to make interesting mistakes, in the right context. They know how to 'prod' things, to get them to reveal themselves. Improvisation is informative, because it uncovers new possibilities. Messing about with interesting material (double cream, footballs, PhotoShop) helps to reveal their 'affordances' – the unexpected ways they behave when treated in unusual ways – and that makes your interactions fresher, richer and less predictable.

The last kind of practice is 'doing it for real'. In the context of sport, for example, playing real matches is not just about doing your best to win; it is 'hardening off' the skills you have been practising in training, firing them in the kiln of competition[29]. Presenting your final year fashion collection is stressful, but, if you want to be a fashion designer, you will have to learn to function under that stress. Even when skills are really well learned, it is all too easy for them to fall to pieces when the pressure is on, and, again, there is no substitute for the first-hand experience of seeing how your skills stand up when they are being tested 'for real'. Developing 'big match temperament' is a learning process like everything else. Playing competitive matches is a kind of practice too, and the debrief after the match should focus as much on 'what can we learn' as on 'how did we do'.

Good coaches and tutors take the long view, and that often means interweaving these different kinds of practice – and explaining to learners what they are up to, and why. Students need to understand why 'improvising' is just as important as 'automating', and why they need to balance learning under pressure with trying things out in more relaxed conditions. Being able to separate and balance these different kinds of practice could well lead to positive developments in the design of practical learning environments.

Observation and experimentation join together very powerfully in the use of role models. Imitation involves looking carefully at how someone else does it, and then trying to implement what you have seen in your own way. Children are powerful and compulsive copiers of what they see respected others doing around them, and this valuable 'learning amplifier' gets honed and directed as they grow up. Learning by imitation is not just a childhood mode of learning; it seems to remain functional and important throughout life. Watching and copying has always, rightly, been seen as a significant part of practical and vocational education, but it has sometimes been taken to epitomise the simplicity of such learning. All you have to do is 'sit by Nellie', watch how she does it, and then go and do likewise. But neither observation nor imitation is as simple as that. As Richard Sennett says in *The Craftsman*, 'learning by demonstration…assumes that direct imitation can occur. To be sure, the process often works,

25. Guy Claxton, in a conversation at a symposium on intuition at the Birmingham City University, June 2008.

26. Anders Ericsson, op. cit.

27. For a good discussion of working on the hard parts, see David Perkins (2009) *Making Learning Whole*, San Francisco: Jossey Bass

28. John Bransford and Daniel Schwartz (1999) Rethinking transfer: a simple proposal with multiple implications, *Review of Research in Education*, 24(2), 61–100; Knud Illeris (2009) Transfer of learning in the learning society, *International Journal of Lifelong Education*, 28(2), 137–48

29. See Guy Claxton and John Allpress (2008) *Building learning power: the key to great coaching*. Unpublished manuscript

but equally often it fails. In music conservatories, for instance, the master often has trouble putting him- or herself back into the rude state of the pupil, unable to show the mistake, only the right way.' [30]

Showing, watching and copying often work better when they are mediated by a senior student – one who is better than you, but still close enough to your experience to understand your errors and difficulties.[31] And the process is often helped by some deliberate and astute explanation and instruction, so you know more clearly exactly what to look out for, where the tricky bits might be, and why they are tricky. So the learner is not just 'aping' but is thinking, selecting, remembering, practising, wondering and experimenting all at the same time. This may be just as – or even more – demanding (if we knew how to measure 'demandingness') than the university student cobbling together thoughts for an essay on Racine, or struggling to get a gas chromatography practical to deliver the prescribed result.

Imagination

The third compartment of the learner's toolkit is imagination, and it, too, contains a number of valuable learning tools. Here we shall briefly mention three: the role of mental rehearsal and visualisation in skill development; the role of reverie in creativity; and the value of non-verbal intuitions and promptings in complex problem-solving. Our understanding of all of these has been significantly advanced by recent research. There is no doubt that the 'mind's eye' is a powerful learning instrument for dreaming up possibilities, and for refining and developing skills. It is what Piaget called *concrete operational thought*, and Bruner referred to as the *iconic* mode.

For many learning purposes, it is useful to be able to control and direct our imaginations. This is what athletes and sports-people do when they are doing 'mental rehearsal' or 'visualisation' of their performance. They are creating 'movies in their head' (as golf legend Jack Nicklaus once put it) of themselves performing better than they (reliably) can in real life. Research in sports psychology has refined our understanding of how to make such mental rehearsal as effective as possible. One practical tip is to make sure you do your imagining 'from the inside', with all the physical and emotional feelings that go along with the performance, rather than from the outside, as if you were a spectator[32].

Sports psychology has generated a good deal of useful practical knowledge about how to use imagination, as well as how to build resilience, how to do quality practice, and so on.[33] There is no reason why this knowledge should not be as useful to apprentices as to athletes. Indeed, this knowledge has begun to be applied in a range of fields. Here, for instance, is a surgeon talking about the way he prepares for an operation, in terms very similar to an elite athlete's preparation for a high jump or a 1500 metres.

'A lot of times…I will look at the angiogram – the dye study that shows the aneurysm and the anatomy around it. And typically what we will do is position the patient, prep the wound, look at the angiogram films and kind of imprint them in your mind. And then just go out into the scrub sink where you are by yourself. You've got five minutes there. And all you're doing is just scrubbing your hands and it's just a time of rote activity…and that's the time I'll try to piece together the anatomy with what I am about to do…I try to picture what I am going to see when I get there, because the x-rays are taken at a couple of fixed angles straight on or from the side, and we are coming in at a 20 degree angle to that. We try to transpose those two views in two dimensions to make it three-dimensional and rotate into the view that you'll be looking at when you come down. And that is helpful.' [34]

School students do better in exams if they have rehearsed in imagination.[35] School principals do better in a tricky meeting if they have imaginatively rehearsed it beforehand. Musicians learn faster if they supplement their hours of practice with mental rehearsal.[36] Though we know of no direct research, there must be a strong presumption that apprentice welders and student nursery nurses would also benefit from such practical knowledge about how to maximise the efficiency and reliability of their own learning.

'Sports psychology has generated a good deal of useful practical knowledge about how to use imagination, as well as how to build resilience, how to do quality practice, and so on. There is no reason why this knowledge should not be as useful to apprentices as to athletes'

30. Richard Sennett, op cit, p 181.

31. See, for example, Jean Lave and Etienne Wenger (1991) *Situated Learning: Legitimate Peripheral Participation*, Cambridge: Cambridge University Press

32. Sian Beilock and Ian Lyons (2009), Expertise and the mental simulation of action, in Keith Markman, William Kleim and Julie Suhr (eds), *Handbook of Imagination and Mental Simulation*, New York: Psychology Press.

33. See Stephen Mellalieu and Sheldon Hanton (eds) (2009) *Advances in Applied Sports Psychology*, Abingdon: Routledge

34. Charlie Brown, The cutting edge: performance psychology with surgeons, presentation as part of a symposium on *Performance psychology innovations: applications for dancers, musicians, surgeons and executives*, Annual Convention of the American Psychological Association, San Francisco, August 2001. Downloaded from www.fps-performance.com/library_article.php?page=article_cutting_edge

35. Shelley Taylor (1991) *Positive Illusions: Creative Self-deception and the Healthy Mind*, New York: Basic Books

36. Much of this research is now summarised in Keith Markman, William Klein and Julie Suhr (eds) (2009) *Handbook of Imagination and Mental Simulation*, New York: Psychology Press.

A second kind of imagination occurs in reverie or 'day-dreaming', and is much less strongly controlled by the learning intentions of the dreamer. Images are allowed to take their own course, rather than being directed for a conscious end. However, such creative reverie seems to benefit from deliberate preparation: helpful ideas 'bubble up' best when prior hard learning and thinking, though unsuccessful, nevertheless has left behind in the brain's neural circuitry a reasonably well-specified 'black hole' for the missing solution. To pursue the analogy, black holes exert a strong magnetic attraction on activity in a wide area around them, and so such neural holes can also attract intuitive ramblings in their vicinity, even when those ramblings may not seem, on the surface, to have much to do with anything.[37] The brains of creative people have been shown to 'toggle' between these focused and receptive modes of cognition as they search for solutions to problems.[38]

Like mental rehearsal, creating these productive lacunae, and being gently receptive to potentially fruitful inklings and intuitions, is a knack that can be explained, taught and learned. As composer Brian Eno once said, one of the most useful things he had learned was 'how to eavesdrop on my own brain when it is talking to itself'. Many a craftsman or woman knows exactly what that means; and many an apprentice could be helped to learn the place of reverie in being a good stage manager, electrician or reporter. In particular, the kinds of repetitive physical activity that form part of many trades and crafts – sandpapering, weeding, chopping vegetables – seem to be conducive to the state of mind in which ideas, possibilities and candidate solutions to vexing problems 'pop into one's head'. There is no reason why apprentices in a wide range of vocational education and training should not be helped to appreciate and cultivate this faculty.

The third kind of imagery is that which accompanies the operation of non-conscious processes of learning and cognition. Learning makes use of a whole variety of bodily and imaginative signals that are less clear-cut than explicit, rational thought, but valuable and informative none the less. As a variety of recent research studies have made abundantly clear, our growing understanding often makes itself known through physical channels before it is (in some sense) ready to appear explicitly in systematic thought.[39] The literature of creativity[40] is full of examples of insights that came first through a prompting of this kind, and was only later developed into a reasoned and justified argument, or into a full-blown proposal or design. In the realm of high science, for example, Albert Einstein famously claimed that:

'The words of the language as they are written or spoken do not see to play any role in my mechanism of thought. The psychical entities which seem to serve as elements of thought are certain signs and more or less clear images which…in my case are of visual and some of muscular type…In a stage where words intervene at all, they are, in my case, purely auditive, but they interfere [sic] only in a secondary stage.'[41]

Imagery comes in different forms. As Einstein says, images can be 'more or less clear'. An insight may come as a realistic picture, as in the apocryphal story of Friedrich Kekulé dozing by the fireside, seeing flames turn into writhing snakes, watching one snake bite its own tail, and immediately see this 'cyclical ring' as the metaphorical basis for an explanation of the puzzling chemical properties of benzene. But there is also a nice family of English words for intuitions of a hazier variety: inklings, promptings, hunches, feelings. Well-controlled experimental studies show that, while these intuitions are far from infallible, they are also demonstrably valid indications of progress and possibility. A survey of Nobel science laureates, for instance, has found that the vast majority of them learned to heed their images and intuitions, and ascribed their ability to make leaps of progress, where other had failed, to this respect for their intuition.[42]

Such intuitive processes seem to be essential in the world of craftsmanship as well. Richard Sennett has argued for a four-stage process of intuition in the crafts and trades. The first, *re-formatting*, is a 'sense of possibility grounded in feeling frustrated by a tool's limits or provoked by it's untested possibilities', and the ensuing 'willingness to see if a tool or a practice can be changed in use'. One is impelled to push a tool, a technique or a material to its limits, and beyond. In the second, *adjacency*, the creative craftsman comes to 'shove close together two quite different technologies… [and] think about what they might, but didn't yet, share.' The mobile phone was born by shoving together the technologies of radio and telephone, for example. The third phase involves a willingness to be *surprised* – and to take one's surprise seriously. Openness to surprise betokens a readiness to have one's assumptions challenged about what is proper or possible – and thus to make a contribution to the advancement of one's vocation. The fourth stage involves a sober recognition that any innovation leaves some problems unresolved, and may bring its own problems and limitations

37. See chapters in Robert Sternberg and Janet Davison (1995) (eds) *The Nature of Insight*, Cambridge: Bradford MIT Press.

38. Colin Martindale (1995) Creativity and connectionism, in Steven Smith, Thomas Ward and Ronald Finke (eds) *The Creative Cognition Approach*, Cambridge MA: Bradford Books.

39. The cognitive validity of these kinds of 'hunches' has been demonstrated by a variety of researchers. For example Kenneth Bowers et al (1990) Intuition in the context of discovery, *Cognitive Psychology*, 22, 72–11. For an overview of this research, see Guy Claxton (1997) *Hare Brain, Tortoise Mind: Why Intelligence Increases When You Think Less*, London: Fourth Estate.

40. For a description of other examples, see Guy Claxton and Bill Lucas (2007) The Creative Thinking Plan: How to Generate Ideas and Solve Problems in Your Work and Life, London: BBC Worldwide

41. Quoted in Brewster Ghiselin (1952) *The Creative Process*, Berkeley CA: University of Berkeley Press

42. Peter Fensham and Ference Marton (1992) What has happened to intuition in science education? *Research in Science Education*, 22, 114–22. This research is reviewed in Guy Claxton (1997) *Hare Brain, Tortoise Mind: Why Intelligence Increases When You Think Less*, London: Fourth Estate

– '*gravity*' has not been defied. In Sennett's view, any artisan should carry within them the seeds of that innovation, and a readiness not just to learn their craft, but to contribute to its development. And any good PVE should therefore work to implant and nurture that seed of ambition and creativity – alongside the virtues of reliability and precision.[43]

Reasoning

As George Lakoff and Mark Johnson put it:

'Reason itself arises from our embodiment. Reason is mostly unconscious. Reason is not dispassionate, but emotionally engaged…Because of these discoveries, philosophy can never be the same again…An empirically responsible philosophy would require our culture to abandon some of its deepest philosophical assumptions.'[44]

This fourth compartment of the learner's toolkit is the most familiar one, certainly in conventional education. In the academic tradition, up through school and beyond, how well one has learned is taken to be indexed by how well one remembers, analyses, explains, critiques and computes – nearly always on paper (or screen). Explicit reasoning is the traditional yard-stick of educational success. But in practical and vocational education, the primary goal is competence – the ability to *do* things well, and not just to talk and write *about* them. And fluency in reasoning turns out to be only a very loose indicator of practical expertise. As we saw, doctors' clinical judgement is barely correlated with their examination grades; some children can balance beams but not explain why, while others can explain but not balance; and so on. The recent research on 'embodied cognition' which we reviewed earlier forces us to reappraise the relationship between competence and comprehension.

But of course that does not mean that disciplined thinking is of no use at all in the context of developing and drawing upon practical expertise. Far from it. It just means that PVE has to teach students how to deploy knowledge and reasoning *in context*. Here are a few of the practical purposes to which disciplined thinking can be put, in the context of carrying on real-world vocations and professions.

Understanding how and why the systems and materials one is working with behave as they do is very useful when problems are complex and situations are non-routine. In well-rehearsed situations, expertise unfolds smoothly, with very little conscious guidance or control. But when glitches occur, it is very useful to be able to construct mental models of the situation, and use those to suggest possible interventions and solutions. The proof of the theoretical pudding is always in the practical eating – the vital question is not 'Was it a well-reasoned argument?' but 'Did it work?'.

To the extent that reasoning helps to generate good, plausible, realistic, workable ideas, it is useful; but it is not useful in its own right, or for its own sake. In many practical situations, the 'working models' that guide effective responding are intuitive more often than tightly-structured chains of logic; but the logic can help.[45] Careful thinking through of possible explanations for a mishap may help to fix the fault. Using metaphors and analogies to import clarity from one area (hydraulics) to another (electricity) requires both creativity, to map the possible applications, and caution, to prevent the parallels being taken too far. And so on.

Clear thinking also helps to work through the possible consequences of different courses of action. It is obviously useful to be able to weigh up the pros and cons of different paths. Yet, here again, recent evidence shows that intuition and incubation – giving your unconscious time to mull things over – are often as good as, and sometimes more effective than, the workings of explicit intellect.[46] Perhaps most importantly, clear thinking enables effective communication, and that makes people better at asking for help, and more effective collective problem-solvers in group situations. All of this is useful; all we need to remember is that these forms of clear thinking are themselves learned competencies rather than hallmarks of intelligence, and their development can therefore be part of a rich PVE experience.

Conclusions to Chapter 4

The main aim of this chapter was to illustrate in some detail how the four habits of the learning mind apply in both vocational and non-vocational learning settings; and to begin to explore fruitful lines of enquiry about how to design and deliver effective PVE. Our main conclusion is that learning environments should both capitalise on, and develop, the habits of mind that lead to effective learning. As well as teaching how to fillet a plaice

'PVE has to teach students how to deploy knowledge and reasoning *in context*'

43. Richard Sennett, op cit., 209–12

44. George Lakoff and Mark Johnson (1999) *Philosophy in the Flesh*, New York: Basic Books.

45. For many practical illustrations of these intuitive working models in action, and the fallibility of full-blown reason, see Gert Gigerenzer (2007) *Gut Feelings: The Intelligence of the Unconscious*, London: Allen Lane; Gary Klein (2003) *The Power of Intuition*, New York: Doubleday

46. See, for example, the study by Chen-Bo Zhong, Ap Dijksterhuis and Adam Galinsky mentioned in Chapter 2.

or undo a corroded bolt, tutors in PVE should be teaching how to attend carefully; how to learn from mistakes and develop projects; how to mentally rehearse tricky skills; and how to turn theoretical knowledge into practical on-the-job talking and thinking. But they can't do that unless they have a language in which to formulate those intentions. This chapter has offered some ideas about what such a language might sound like.

If vocational and academic learning are to achieve equality of esteem, we have argued, they need a common language in which it is not at all obvious that learning in one domain is inherently more complex or more 'intelligent' than in the other. Professors of philosophy have developed sophisticated ways of gathering and assaying information; of experimenting with ways of crafting a lecture or a paper; of imagining alternative possibilities; and of following through chains of reasoning to robust conclusions. But mechanics have their equivalents of each of these, accountants theirs, and window-dressers theirs. If one takes the trouble to find out, the kinds of investigating, experimenting, imagining and reasoning that go on in a repair shop or a retail outlet are as rich, interesting and appropriate as those that go on in a university seminar. And acknowledging that removes one of the main underpinnings for the pernicious and abiding lower esteem in which practical and vocational learning have for too long been held.

From each of the four habits of minds there are useful lines of enquiry for those interested in PVE to pursue. At this stage, rather than attempting to offer strong prescriptions about how PVE environments should be structured, we prefer to pose our thoughts as questions to ponder.

Investigating
How can learners get better at paying attention, locking their minds on to what they need to attend to? Which kinds of attention work best in different contexts? How can learners be encouraged to find the state of flow more often, when they are rapt in the moment of their practical learning? Is practical learning more likely (than other more 'academic' kinds) to induce flow? How can we best balance the fragmented world of internet-surfing with more sustained periods of concentration? How many tasks can be undertaken multiply without a loss of performance?

Experimenting
What can PVE learn from the literature on practising? Given the current interest in project work, both at A level and within the Diploma in England, what learning methods and processes might be most supportive to learners developing, both individually and in a group, a sustained piece of project work over time? How can such project work be structured so that it provides a rich context for developing sustained attention, intelligent tinkering, reflective self-evaluation, and constructive discussion and interaction with peers?[47]

Imagining
Give what we are discovering about different kinds of visualisation and mental rehearsal, how and when might those engaged in PVL benefit from using such techniques? How is the mental control different when fashioning a piece of wood from designing something on a computer, for example? Whenever learners are facing a test of their skill, what kinds of mental rehearsal would benefit them most? Can they be trained to make good use of mental simulations in the context of real-world problem-solving? How can trainees be helped to appreciate the value of creative reverie as well as methodical planning and preparation?

Reasoning
Of the four habits of mind, reasoning is the one most associated with general education. But how can explicit thinking be cultivated so that it becomes a useful and habitual tool for learning on the job, and not just something necessary to pass exams? How do we avoid the trap of elevating an ability to write about something above the ability to do that thing? How can tutors help students to become thoughtful practitioners, as well as skilful ones? How are knowledge and theory best taught, so that they become active resources in the practitioners' minds when they are in very different contexts from those of college?

Our 4-6-1 model is preliminary, at this stage, but we think that it is already showing its value in its ability to provoke productive pedagogical and organisational questions such as these.

'The kinds of investigating, experimenting, imagining and reasoning that go on in a repair shop or a retail outlet are as rich, interesting and appropriate as those that go on in a university seminar'

47. This area of research is currently being explored by the Centre for Real-World Learning with a grant from the Esmée Fairbairn Foundation.

Chapter 4
Frames of mind

Happiness is not a condition that is produced or stands on its own; rather it is a frame of mind that accompanies an activity. But another frame of mind comes first. It is a steely determination to do well.[1]
George Will

The last chapter focused on describing some of the most important tools of the learning trade. However, it is not just tools that an effective real-life learner needs; it is temperament as well. You may be *able* to carry out an effective on-line search for the information you need, but if you do not feel motivated to do so, or feel pessimistic about your chances of being able to solve the underlying problem, then your search is going to be less powerful and persistent than it might need to be. Thus, in our 4-6-1 model of learning, the habits of mind are supported and directed by a set of what we call *frames of mind*: the broader dispositions of character that enrich, direct and support a person's learning activities. People differ in these general attitudes and orientations towards strangeness or difficulty, and the evidence suggests that some of them are more positive and helpful than others. The evidence also suggests that these frames of mind are, to a significant extent, learnable[2].

As the PVE tutor helps students or trainees learn the skills of their trade, therefore, he or she is also able to help them develop the frames, as well as the habits of mind, that will underpin a deep and abiding inquisitiveness about their chosen vocation or profession. They are being coached to become not just competent electricians or beauticians, but curious, creative, thoughtful contributors to, and developers of, the 'guilds' to which they belong. Those frames of mind, we believe, benefit the individual and those they work with, the 'communities of practice' of which they are members, and society as a whole. By helping people develop the attitudes that underpin confident and proactive learning, we are building both subjective well-being and economic productivity.

The frames of mind on which we focus here, as previously outlined, are curiosity, determination, resourcefulness, sociability, reflection and wisdom. These attitudes appear time and again in surveys of the 'wider skills', 'key competencies', 'character strengths' and so on with which many educators and education systems around the world are currently concerned.[3] In this chapter, we will merely attempt to describe briefly each of these frames of mind, and to illustrate the innovative research base on which they rest.[4] As in the previous chapter, one of our underlying intentions here is to suggest that these strengths are widely and variably distributed across occupational groups in society. A lawyer may be weak in some or all of them, just as a bricklayer may be. Equally, a nursery nurse or an animator may be as curious, determined, resourceful, sociable, reflective and wise as any professor.

Curiosity

All learning (except sometimes in school) starts from need or curiosity. Beyond an immediate need to pass an exam or fix a glitch, learning is driven by wondering and questioning. For the scholar, a visceral dissatisfaction with the conclusions of a rival's journal article drives the search for a more meticulous analysis, a new experiment, or an improved conceptualisation. For the glass-blower Erin O'Connor, the desire to make a goblet worthy of her beloved Barolo wines drove thinking, experimenting, reading and struggling to develop a new technique that would serve her purpose (and then she wrote a scholarly article about the process). Most interestingly, she found that she had to develop a new kind of extended, totally focused concentration – different from, but equivalent to, the kind of concentration that enables a philosopher at a conference to follow the thread of a densely written and rapidly read-out presentation.[5]

To be curious, one needs to be open-minded, to believe that one's own questions are worth asking,

1. George Will (1991) *Men at Work; the craft of baseball*, New York: HarperPerennial
2. See Bill Lucas and Guy Claxton (2010) *New Kinds of Smart; how the science of learnable intelligence is changing education*. Buckingham: Open University Press
3. For a detailed overview of wider skills, see Bill Lucas and Guy Claxton (2009) *Wider Skills for Learning; What are they, How can they be Cultivated, How could they be Measured and Why are they Important for Innovation?* London: NESTA
4. This research is described in more detail in a forthcoming book, Bill Lucas and Guy Claxton (2010) *New Kinds of Smart: How the Science of Learnable Intelligence Is Changing Education*, Buckingham: Open University Press. This book addresses the role of these frames of mind in education and real-world learning more widely, and does not focus specifically on practical and vocational learning and education.
5. Erin O'Connor (2005) Embodied knowledge: the experience of meaning and the struggle towards proficiency in glass-blowing, *Ethnography*, 6(2), 183–204. This example is discussed in detail in Richard Sennett's *The Craftsman*

and to be optimistic that one's learning labours will be worthwhile. All of these are malleable traits, capable of being grown and strengthened in conducive environments. Students whose questions are taken seriously become more questioning.[6] Optimism – the feeling that one's efforts are worthwhile – has been shown by Martin Seligman to be a trait that is readily capable of expansion.[7] For example Seligman has shown that people may have developed a habitual 'explanatory style' that encourages pessimism – believing that difficulties are likely to be insuperable, for example. But with some self-awareness, and skilled encouragement to challenge this habit, optimism – and hence curiosity – become stronger. The scientific literature on 'positive psychology' is now full of well-researched examples of how the growth of curiosity can be stimulated (and how it can also be suppressed).[8]

The cultivation of a curious frame of mind in the current educational system in the UK is not always easy, especially where the emphasis is on the development and assessment of narrowly-defined skills and knowledge. But for many, learning a practical subject with a more experienced peer or adult, it is relatively easy to encourage both good questioning techniques and a questioning frame of mind, assuming that such behaviour is seen as positive by the school, college or workplace. In terms of PVL, more open-ended introductions to new concepts and processes might be more appropriate in order to build on the natural inquisitiveness that learners bring; simply by asking learners what they think they already know and what they need to know is generally a useful strategy[9].

Determination

To cut a head of hair, to write a report, to design a garden all require the willingness to take risks, to try something new, and, probably, to recover from failure or criticism and try again. Learners who give up quickly, who get easily disheartened, who fear to try something they don't know they can yet do, learn more slowly and more shallowly than others.

A major research programme by Stanford University's Carol Dweck has shown that such resilience is undermined by the need to get fast affirmation of one's worth and ability. Some students have learned to seek affirmation of their performance – crudely, to look good and to win praise – and this need leads them to avoid challenges where they are unsure of success, and to feel embarrassed or upset when they are seen to struggle or make mistakes. Such students, when they do make mistakes, will ignore information that will help them do better next time, because they are too busy coping with the distress of having 'looked stupid'. The good news from this research, though, is that such habitual patterns of interpretation can be changed. With only quite short interventions, and with encouragement from tutors, many of these so-called 'helpless-prone' students can become more resilient and adventurous in their learning.[10]

As far as we know, there is no research that directly compares the resilience of apprentices in the construction industry with that of undergraduates studying history. But Dweck's research has shown that the strength of someone's resilience in the face of difficulty is not related to their level of academic ability. High-achieving scholarly students are as likely to crumple under pressure as those who talents lie in more physical or practical domains. It is certainly true that many academically successful students have learned to walk the narrow plank of learning required to get good results, but easily 'go to pieces' in the face of novel kinds of challenge. So one cannot assume that academically 'able' students are more resilient than those who prefer to learn with their hands and their feet: on the contrary.[11]

In terms of PVL it would seem sensible to engage all the adults who teach young people (teachers, tutors, mentors, work placement supervisors) in developing an understanding of growth mindsets and the kinds of strategies by which learners can develop and maintain these and so build their resilience and ability to bounce back from setbacks.

Resourcefulness

By resourcefulness, in this context, we mean the disposition to make good use of material resources to support performance, problem-solving and learning. Recent research on what is called 'distributed cognition' has revealed that human intelligence is almost always 'person-plus' – that is, people habitually amplify their own mental and physical powers by making good use of all kinds of external tools and supports. Indeed, as we saw in chapter 2, neuroimaging studies have shown

'The strength of someone's resilience in the face of difficulty is not related to their level of academic ability'

6. See examples in Guy Claxton (2008) *What's the Point of School?* Oxford: Oneworld
7. Martin Seligman (1998) *Learned Optimism*, New York: Free Press
8. See, for example, Christopher Peterson (2006) *A Primer in Positive Psychology*, Oxford: Oxford University Press
9. See the Assessment for Learning and Philosophy for Children approaches for many tried and tested ideas
10. Carol Dweck (2006) *Mindset: The New Psychology of Success*, New York: Random House.
11. Carol Dweck (2000) *Self-Theories*, Hove: Psychology Press

that the human brain readily comes to represent familiar tools as if they were actually parts of our own bodies. The representations of our bodies in our brains – our 'body schemas' – can easily expand literally to include our tools, whether they be pens, spectacles, racquets, books or laptops. As Edinburgh philosopher Andy Clark, author of the 2008 state of the art review of this area, *Supersizing the Mind*, has pointed out, for a hardened user, there is no difference in kind between losing their Blackberry and having a mini-stroke. The current ubiquity of digital tools has intensified our awareness of this tendency for self-augmentation, but it has been in our blood for a long time. By analogy with the Blackberry: to steal a blind person's stick is not just theft of property; it is a crime against the person.[12]

Thus a disposition towards spotting, seeking and crafting tools to amplify our own capabilities is a deep component of human intelligence. To treat people as if they were, or ought to be, person-solo – for example, to deprive them of their cognitive prostheses for one of the most important three hours of their young lives – is badly misguided. It makes as much sense to take away someone's notebooks as to deprive them of their spectacles, or to take away David Beckham's football boots or Ronnie O'Sullivan's snooker cue and say 'Now show me how good you are'. Scholars and craftsmen differ in the tools of their trade, but not in whether they are sophisticated tool-makers and tool-users.

Many vocational crafts and trades rely on physical tools, and the disposition to think like 'person-plus' is therefore an indispensable asset. Both tutors and students need to understand that time spent familiarizing oneself with tools and exploring their nature, their limitations and their potential, is absolutely vital. This extension of the person to include the tool cannot be achieved through conceptual understanding. The brain's circuitry cannot adjust itself the minute something is comprehended; it takes experience. The disposition to explore attentively the behaviour of tools, to be on the look-out for useful additions to one's toolkit, to customize and develop tools, and to cannibalise and co-opt things at hand to serve as the tools one needs: this frame of mind is a vital asset. The more we can allow learners greater exposure and access to tools, resources and media, in both educational and workplace settings, the better. Equally the more we invite them to use tools – especially ICT ones which they use in their other lives – the more we are empowering them.

Sociability

The lone craftsman and the lone academic both exist, but they are not the norm. The performance of both artisans and scholars is more likely to be the tip of a large iceberg of collaboration, coaching, watching, discussing, brainstorming, confiding, sharing ideas, and generally working and learning alongside other people in a host of ways. There is physically working and training alongside others. There are people who offer coaching, support, feedback and advice. There are trusted confidants and sounding boards: good listeners who help you clarify your own ideas and directions. There are models and competitors with whom one has imaginary conversations inside one's head. There are the authors and producers of admired objects and performances. All this hold true for lawyers, business executives, journalists and architects, as well as gardeners, artists, nurses, actors and cooks.

Judy Silver in her PhD at the University of Exeter has documented the vital importance of these kinds of relationships in the context of trainee chefs working and learning in Jamie Oliver's restaurant-cum-apprenticeship scheme 'Fifteen'.[13] Getting good at the social side of learning means being alert and open to all the sources of information and advice there are – and getting better at balancing and orchestrating them. Sometimes it works better to sort your ideas out quietly before you talk to the group (in the case of brainstorming, this is almost always true). Sometimes ideas and ambitions are too delicate to talk about – yet.[14] An effective apprenticeship will surely help trainees to cultivate a sociable as well as a solitary frame of mind.

If PVE can clearly offer increased use of group learning along with support and development for teachers to help them make greater use of group learning in terms of organisation, the allocation of learner roles, the engagement of students in determining the allocation of roles. The sociable side of learning is taken up in more detail in the following chapter.

Reflection

There is a growing consensus in the cognitive science community that human beings possess two

12. Andy Clark (2009) *Supersizing the Mind*, Cambridge: Cambridge University Press

13. Judy Silver (2009) *Mediated Learning Experience in a Community of Practice: A Case Study*, dissertation submitted for a PhD, University of Exeter

14. Peter Heslin (2009) Better than brainstorming? Potential contextual boundary conditions to brainwriting for idea generation in organisations, *Journal of Occupational and Organizational Psychology*, 82(1), 129–145

'Scholars and craftsmen differ in the tools of their trade, but not in whether they are sophisticated tool-makers and tool-users'

different intelligent systems that work, when they work well, in concert.[15] The first is the biologically older Habit System (HS) that has direct control of our skills and sensibilities. The 'knowledge' of the Habit System is directly compiled into the strengths of connections between millions of filaments in the brain and body. The second is the Reflective System (RS) that stores 'knowledge' that is not yet in direct control of feelings and actions, but which can act as a brake, a check or a guide to what is about to happen. The Reflective System is rather like the internalised voice of a more knowledgeable teacher or guide, who is able to offer 'coaching tips' that can improve the way we function – but which have to be heeded, and which take time to be worked into the neuromuscular connectivity of the Habit System.

It is the RS that offers second thoughts and alternative possibilities; that enables us every so often to stand back, take stock, and decide to try 'the road less travelled', rather than the reflex habit. This is a powerful system for enabling human beings to amplify and accelerate their own learning – they can carry their 'best coach' with them, rather than having to wait for the occasional session with an external tutor or mentor. The RS is the one that enables us to unlearn and relearn – to change our habits – rather than just to learn by gradually assimilating what comes along.[16]

For the RS to be effective, it has to be active at the right moment. Your inner coach has to whisper in your ear a possibility that is different from your habit, but which is timely, appealing and do-able. The moment where you realise that there is such a choice is a moment of *self-awareness*. Without the habit of stopping and checking – switching into RS-mode for a moment – all the knowledge and advice stored in the RS is as much use as a well-stocked, but well-locked, larder to which you have lost the key. If you do have the meta-habit of flipping into RS-mode, then the quality of the goods in the pantry makes a big difference. Are you hearing the voice of a wise, experienced, coach who knows you and your limitations and aspirations well? Or is it the voice of a nagging, critical, demoralising judge? We should remember that it is also possible to over-use the RS, and have it constantly interrupt and question habits that might be perfectly effective. When this happens we tend to call it self-consciousness rather than self-awareness.

The Reflective System makes use of three kinds of information. The first is Coaching Instructions internalised from other people. These inner voices of guidance may originate with teachers, tutors, coaches and mentors, but also from parents, siblings and peers. The second kind of information is Received Explanations of various kinds, that might help you diagnose your situation, and design your own coaching instructions, better. (Philosophy, religion and self-help books and magazines are full of such putatively useful explanations.) Conceptual understandings and working models are sources of guidance especially when fluent, intuitive expertise falters or fails.

Thirdly, there are Personal Memories and Impressions. Most other animals don't seem to hold specific memories for past events. They extract the learning juice from their experience as they go along, and throw away the husk. The problem is that this is wasteful of information, because they were about some particular kind of business or other at the time, and so the learning that accrued was relevant only to that current purpose. If you were hungry, you won't have registered the potential of the banana to act as a prop in an improvised play. If you were looking for a date, you may not be alert to the possibility that the object of your attention might have been able to help you with your NVQ project essay. Being able to hold on to memories is a clever evolutionary trick, because – when and if you are minded to do a bit of reminiscing – it enables you to put your experience through a 'second pressing', and extract learning from it that might be of use in the context of different needs and interests.[17] And when it comes to creativity, when the current collection of distilled habits turns out to be inadequate, mulling over these stored residues might just bring to light the seeds of a new direction.[18]

We might speculate that the conventional education system (both reflecting and reinforcing wider cultural misconceptions) has neglected this basic function of knowledge, and assumed instead that mere accumulation of memories, ideas and good advice is somehow of value *in its own right*, without any further ado. For someone who makes their living as a teacher or a coach, it may be: the ability to discuss this kind of stored knowledge is their stock in trade. But eventually knowledge, however deep and true it may be, needs to be cashed into action – especially in the context of practical and vocational learning. And that requires determination, self-awareness, and the realisation that knowledge does not automatically seep into practice, and there is no reason why it should. It has to be used within the Reflective System as an active guide to over-riding old habits and developing new ones.

The fascination with the accumulation (and accreditation) of knowledge has led to a gross

15. Shelly Chaiken and Yaacov Trope (1999) (eds) *Dual Process Theories in Social Psychology*, New York: Guilford

16. This outline sketch of the Reflective System draws on research by David Perkins and Barry Zimmerman. See David Perkins (1995) *Outsmarting IQ: The Emerging Science of Learnable Intelligence*, New York: Free Press; Barry Zimmerman and Anastasia Kitsantas (2005) The hidden dimension of personal competence: self-regulated learning and practice, in Andrew Elliot and Carol Dweck (eds) *Handbook of Competence and Motivation*, New York: Guilford Press

17. Arthur Glenberg (1997) What memory is for, *Behavioral and Brain Sciences*, 20(1), 1–56

18. Guy Claxton and Bill Lucas (2007) *The Creative Thinking Plan: How to Generate Ideas and Solve Problems in Your Work and Life*, London: BBC Worldwide.

underestimation of the determination and attention that is required to turn it into working skills and habits. Habit change and habit formation are basic kinds of learning, but they are slow processes. It takes time and experience to tune a neural network from naivety to virtuosity – about 10,000 hours of quality practice is the general estimate.[19] The deliberate attempt to apply knowledge and instructions to the development of habit is crucial – mindless practising won't do it – but takes time. It is helpful to bear in mind what we call, in our work with teachers, the 'mayonnaise' model. If you are impatient and do not add the oil of instruction very slowly, giving plenty of time for experience and practice to blend the instruction into habit, then Knowledge and Habit separate out (the mind 'curdles') and you do not get the silky, sophisticated increment in expertise you were hoping for. The histories of the traditional apprenticeships suggest that this appreciation of the time it takes to develop expertise is not new. But one could argue that it has been somewhat forgotten in the current climate of short courses designed to achieve rather crudely specified 'standards' and 'levels'.

Misunderstanding the place of knowledge in the development of expertise has also led us to assume that the translation tends to go in that direction – from Knowledge into Competence – and that expertise develops though the *application* of understanding. In the beginning, and up to a point, it does, in the way I have described. But it is equally true that knowledge and understanding often appear only *post hoc*. This has been well demonstrated in neurological and psychological experiments by Antonio Damasio and the late Donald Broadbent and his colleagues at Oxford. Indeed, Broadbent has shown how trying to apply what you already believe can get in the way of paying careful attention to experience, and so slowing rather than speeding the development of skill.[20] Commenting on the slow development in the skill of using a scalpel in surgery, for example, Richard Sennett notes, 'as in all craftwork, understanding of what one was doing appeared only slowly, and after the fact of doing it'[21].

Like the first four frames of mind, reflection is itself a skill and a disposition that grows with experience and encouragement. It is no use – as some simple-minded but enthusiastic courses have done – just sitting 18-year-olds down and telling them, at the end of a hard day on the wards or in the workshop, to 'reflect': no more use than standing them on a tennis court and expecting them to be able to return a Federer serve. These facets of powerful learning take time to learn, and they need sympathetic and knowledgeable coaching if they are to do so.

Wisdom

To be an effective learner, we argue, it is not enough just to meet your challenges and pursue your interests as skilfully as you can: you need to be clear about what your deepest interests really are. You need to be able to see the big picture; to balance and resolve what is sometimes a bewildering portfolio of competing and conflicting desires and threats. 'What to do for the best?' is perhaps humankind's deepest moment-to-moment challenge, especially when we are living in a world that is full of opportunity, complexity, uncertainty and risk. The idea of the 'moral compass' has become (in the mouths of opportunistic politicians) something of a cliché, but it seems to us that the sense to choose the 'right' challenges, and to construct interests and trajectories in life that are (in some sense) truly worthwhile, nurturing and satisfying, is an important element of 'learning power'.

Recent research in the field of positive psychology shows that people are frequently prone to forget what 'really matters most', and act as if relatively unimportant things were actually matters of life and death. In an article entitled 'Miswanting: some problems in the forecasting of future affective states', Harvard psychologists Daniel Gilbert and Timothy Wilson have shown that many people consistently over-estimate how happy desired events will make them, and how unhappy undesired events will make them.[22] So an important aspect of wisdom, as we use the term, means to yoke our intelligent capacities to a clear and accurate sense of enlightened self-interest. Someone whose head is a noxious stew of resentments, insecurities, imagined slights and unfulfilled dreams may find it hard to know how to act 'for the best' even in relatively straightforward, everyday contexts, let alone at more obviously complex junctures. They may then act in ways that are mercurial and untrustworthy, or even apparently self-destructive. Many surveys show that young people today are particularly prone to such pressures and confusions.[23]

'It takes time and experience to tune a neural network from naivety to virtuosity'

19. See Anders Ericcson (1996) *The Road to Excellence*, Mahwah NJ: Laurence Erlbaum

20. Anthony Bechara, Hanna Damasio, Daniel Tranel and Antonio Damasio (1997) Deciding advantageously before knowing the advantageous strategy, *Science*, 275, 1293–5; Dianne Berry and Donald Broadbent (1984) On the relationship between task performance and associated verbalisable knowledge, *Quarterly Journal of Experimental Psychology*, 36A, 209–231

21. Richard Sennett, op cit, p199

22. Daniel Gilbert and Timothy Wilson (2000) Miswanting: some problems in the forecasting of future affective states, in Joseph Forgas (ed), *Thinking and Feeling: The Role of Affect in Social Cognition*, Cambridge: Cambridge University Press.

A complementary line of research suggests that one of the forms of 'happiness' that does seem to deliver the goods, as we saw earlier, is 'pride in a job well done'. Being able to apply your habits and frames of mind to a worthwhile but non-trivial challenge, and to arrive at a satisfying product or solution, is both engaging and gratifying.[24] The state of absorption or 'flow' arises when one's capabilities are optimally stretched (but not overwhelmed) by a worthwhile challenge, and this state, though demanding, is reliably associated with feelings of well-being.

So a rounded education needs to help young people find what they truly love to do and want to be good at, and to see that some of the 'happiness options' they might consider could have toxic effects on their own deeper or longer-term well-being. They need to be helped to develop the confidence to pursue and engage with all kinds of things that are difficult but worthwhile. And they need the self-awareness to be able to resist courses of action that damage their own well-being, and the well-being of the social networks in which they are, like it or not, enmeshed. This wise frame of mind is, we think, an order of magnitude more important than whether they manage to achieve certain minimal standards of proficiency. Many schools, colleges and workplaces have their own priorities well aligned, and have developed strong cultures within which everyone can take such ethical and moral issues seriously. But not all. Clearly PVE needs to help young people not only become skilled at their chosen vocation, but also to find pleasure in seeing it as a continuing source of interesting opportunities to stretch their expertise and understanding.

Conclusions to Chapter 4

This concludes our brief sketch of the 4-6-1 model of practical and vocational learning. In the next chapter we will consider in more detail how the model acts as a framework for developing effective and empowering forms of PVE. We think the model summarises a number of the most powerful aspects of the effective learner's toolkit and temperament. And we believe that the research on these habits and frames of mind suggests that each of them is capable of development.

The traditional impoverished vocabulary of learner characteristics seems to focus on aspects of learners, such as their 'academic ability', that are relatively fixed, or on those that are rather judgemental ('unmotivated', 'disaffected') that again seem to point to factors that are largely beyond educators' control. By contrast, our reading of the research that underpins the 4-6-1 model suggests that there are a number of salient learner characteristics that well-designed educational programmes can aim to strengthen systematically. Thus our model clarifies and gives heart to a PVE curriculum that develops vocational skills and knowledge, for sure, but does so in a way that cultivates valuable attitudes toward learning more generally.

As in the previous chapter, we conclude this one by raising some questions that PVE practitioners might like to ponder, as they think about how to develop ever more effective forms of practical education, ones that capitalise ever more effectively on the learning sciences.

Curiosity

How might we harness and strengthen – or in some cases rehabilitate – young adults' natural curiosity? Are there forms of enquiry-based or problem-based learning that would engage this curiosity more powerfully than working methodically through 'the things they have to know'? Could trainees be more strongly involved in researching the things they need to know, and designing their own learning experiences? Can the English curriculum's emphasis on the development of 'personal learning and thinking skills' form a strong thread that runs through PVE?

Determination

Are problem-based forms of learning effective at building up students' learning stamina and perseverance? Can the self-defeating beliefs that some of them may hold about their own learning abilities be challenged head on? Would it be worth exploring the kinds of workshops that Carol Dweck has devised that are provably effective at strengthening learners' confidence and optimism? How can we present learning so that students come to see their courses as launch-pads for lifelong learning, rather than as necessary hurdles to be jumped on the way to gaining grades and qualifications?

Resourcefulness

How can PVE students be helped to think of their tools as personal prostheses of their trade, and not

'One of the forms of "happiness" that seems to deliver the goods is "pride in a job well done"'

23. See, for example, Stephan Collishaw et al (2004) Time trends in adolescent mental health, *Journal of Child Psychology and Psychiatry*, 45(8), 1350–62.

24. See Martin Seligman (2002) *Authentic Happiness*, New York: Simon and Schuster; Mihaly Csikszentmihalyi (2002) *Flow: How to Achieve Happiness*, London: Rider; see also www.cs.bham.ac.uk/research/projects/cogaff/pride.html

as merely inanimate clobber? How should courses and examinations be designed to encourage their sense of resourcefulness? What sort of activities might build up the disposition to look for the technological affordances of the things they find around them, so they can become ingenious co-opters and customisers of useful resources?

Sociability
How can we build up students' confidence to ask questions, collaborate effectively, and ask for help and advice when they need it? What sorts of activities develop their ability to take well-meant critical feedback without getting defensive, and to give feedback to others in a way that is gracious and respectful? Should we be helping them to learn to balance the sociable and solitary sides of learning and working?

Reflection
How can we help students develop their own ability to be self-guiding and self-correcting in their learning? What would change in the way tutors work if they thought of themselves as modelling the voice of the internalised coach that students would carry around in their heads for the rest of their careers? How shall we coach the ability to know when to 'stop and think', and when to enjoy deep, unselfconscious immersion and absorption in activity?

Wisdom
What opportunities do we have to help students develop an all-round openness to and interest in learning and exploring new things? How can work-place tutors and mentors in a specific occupation help their trainees discover their 'element' (as Ken Robinson puts is), even if that turns out to be in a different field? How can young people who have had a dispiriting experience of formal education be helped to rediscover their ability to explore and craft their own satisfying trajectories in life?

As in the previous chapter, we do not claim that our model leads directly to a definitive set of design principles for PVE. That would be wildly premature. We do, though, think that its ability to help us frame questions such as those above demonstrates its value.

'What sorts of activities develop the ability to take well-meant critical feedback without getting defensive, and to give feedback to others in a way that is gracious and respectful?'

Chapter 5
Cultures and contexts

As the world becomes more inter-connected organizations that will truly excel in the future will be (those)…that discover how to tap people's commitment and capacity to learn.
Peter Senge[1]

In the last three chapters we have been looking at a working model of PVL or as we are calling it, real-world learning. But apart from 'sociability', the fifth of our six frames of mind, our focus has mainly been on the individual learner's end of things. In doing this we have drawn on what we know from the learning sciences. First we have attempted a working model of real-world learning and then we have explored, at a more detailed level, the habits and frames of a learner's mind in action. Our focus has been on learning and learners. We have, we believe, identified in some detail the psychological equipment that can make for fulfilled and effective lifelong learners in the context of PVL.

We now need to change gear and apply as much of this as we can in context, beginning to consider ways in which colleges, schools and workplaces can construct PVE experiences which capitalise on the kinds of presence, habits and frames of mind on which we have dwelled. For it is our contention that we can stretch and develop all of the habits and frames of minds we have been describing and that, if we were to do so, there is good emerging evidence that learners will get better at learning. They will, we have argued, become more motivated and engaged, more skilful at developing expertise in any particular vocational domain and more likely to leave a residue of confidence and enthusiasm and recognise cues so that they can transfer learning from one domain to another.

In this chapter we want to move out from the individual to groups of individuals and consider the cultures and contexts in which learning takes place. To what extent is almost all learning social? What do we know about the kinds of learning cultures which are hospitable to learning and those which are hostile? How much of PVL is informal? What about the contexts of PVL, the schools, colleges and workplaces, with their classrooms, workshops, salons, labs, offices, factories and outdoor spaces? To what extent is learning situated in a specific place? And how can we get better at transferring what we learn in one domain and apply it in another? What are the PVL design principles that might most probably lead to effective transfer?

The social nature of learning

Most learning has a social element. It takes place with others who may be co-workers, peers, co-learners or those who seek to help us get better at whatever we are trying to do (all the while, hopefully, learning themselves). At its simplest level a small piece of research shows that social interaction is an important part of the learning experience.

Oscar Ybarra and colleagues at the University of Michigan[2] have shown just how valuable social interaction is by conducting two experiments. First they surveyed 3610 people between the age of 24 and 96 to establish their patterns of social interaction. They gave each person a widely used test of mental function and, after controlling for variables, they looked at the connection between frequency of social contact and mental function. It turned out that the more social contacts subjects had, the better their cognitive functioning was.

The researchers then went on to compare the respective benefits of various kinds of activities on college students[3]. Each student was allocated to one of three groups. The first group had a discussion about a social issue for ten minutes. The second undertook tasks such as a comprehension test and a crossword puzzle. And the third, the control group, watched a ten minute extract from 'Seinfeld'. All the students then undertook tests of their mental processing and working memory. The results showed that students who spent ten

1. Peter Senge (1990) *The Fifth Discipline: The art and practice of the learning organization*, Doubleday, New York
2. Oscar Ybarra, Eugene Burnstein, Piotr Winkielman, Matthew C. Keller, Melvin Manis, Emily Chan and Joel Rodriguez (2008) Mental exercising through simple socializing: Social interaction promotes general cognitive functioning. *Personality and Social Psychology Bulletin*, 34, 248–259
3. Ibid

minutes talking about an issue boosted their cognitive performance just as much as those who took part in more obviously intellectual activities. In other words, such is the power of social interaction that just ten minutes spent talking with others can enhance mental performance.

In their private lives, today's young people are growing up in a socially networked world. YouTube, FaceBook and MSN Messenger are just three current examples of the online social spaces in which they spend much of their time. The world has never been a more networked place yet for the most part schools and colleges still remain stubbornly focused on individuals. Charles Leadbeater[4] has recently explored the impact of the Web on the way we view the world and concludes that the current generation's minds are being powerfully shaped by life in virtual worlds and on social networking sites. He concludes that today's young minds are as much social as individual: 'they will look for information themselves and expect and welcome opportunities to participate, collaborate, share and work with their peers'. They are highly disposed to be sociable in their learning as well as in their leisure.

This frame of mind is often more highly developed in students than it is in their teachers, and it is unfortunate, we believe, if, through institutional inflexibility and inertia, this disposition is thwarted. It seems impossible that schools, colleges and independent learning providers can continue to resist this growing pattern of interaction and collaboration in the ways they structure learning and assessment. They will surely have to change their attitude to knowledge, valuing the capacity to collaborate at least as highly as the ability to sit in isolation in an examination hall, or demonstrate skill as an individual rather than as a participating member of a team. Take just one example. Could apprentices not communicate with their tutors and, where appropriate, their peers, using PDAs, the same devices on which they could be working on assignments or recording reflections on their progress?

One of the most influential proponents of this social view of learning was the Russian psychologist Lev Vygotsky.[5] Knowledge, Vygotsky argues, is something that we construct socially through our interactions with our peers and with those who are more knowledgeable than ourselves. From Vygotsky's translators we have acquired the strange phrase 'zone of proximal development'. But unlikely as it may sound, it is a very useful idea in PVE. The zone of proximal development describes the difference between what a learner can do without help and what he or she might be able to achieve with some social support. It is at the heart of apprenticeship, coaching and teaching. For the good teacher understands the learner's stages of development and is able to provide the necessary 'scaffolding' – tools, maxims, access to other more expert learners and so forth – for him or her to progress and grow.

A Further Education teacher's expertise at effectively and quickly finding out what a learner knows and assessing their potential for progress – a real kind of personalisation – along with their pedagogical skill in matching method to task becomes critically important. The old Guild mix of apprentices, journeymen and masters had built in opportunities for learning of the kind Vygotsky described. What is the contemporary equivalent? To what extent could those engaged on PVE courses explicitly be trained to become mentors for their peers?

Situated learning

In our first report, *Mind the Gap* and in the previous chapter of this one we touched on the work of Jean Lave and Etienne Wenger[6] on communities of practice. We looked at the way in which most learning in everyday life is situated, occurring where people and resources combine to carry out an activity. So footballers meet in the park on a Sunday morning, budding young car mechanics gravitate towards an older friend with a garage, or aspiring naturalists meet at the end of a bus ride late in the evening on a country road to go badger-watching.

But Lave and Wenger chose their case studies from various groups of apprentices who were learning a trade or profession – midwives in Mexico, tailors in Liberia, US Navy quartermasters and butchers in US supermarkets, for example. These case studies challenge formal PVE in that their argument is, essentially, that learners need the social conditions for learning and not necessarily much formal PVE

4. Charles Leadbeater (and 257 other people) (2009) *We Think*, London: Profile Books

5. Lev Vgotsky (1978) *Mind and society: the development of higher mental processes*, Cambridge, MA: Harvard University Press

6. Jean Lave and Etienne Wenger (1991) *Situated learning; legitimate peripheral participation*. Cambridge: Cambridge University Press

'Students who spent ten minutes talking about an issue boosted their cognitive performance just as much as those who took part in more obviously intellectual activities'

teaching. Mayan midwives do not teach anything, preferring simply to allow those learning to watch them again and again at many stages of the birthing process. Liberian tailors, again while not teaching in the formal sense, deliberately structure the experience of apprenticeship 'in reverse order'. Learners start by observing the end of the process and gradually move their way backwards though sewing, cutting, designing and measuring.

Lave and Wenger's views may at first sight seem incompatible with a formal PVE system – too organic, too much left to chance. But it seems to us that their fundamental conviction, that learning is part of and situated in real life, is a powerful one. We wonder what the equivalent of the decision by the tailors to learn the trade in reverse order might be in each of today's many different vocational areas. For a simple restructuring of experience clearly opens up powerful opportunities for apprenticeship.

The field of situated learning helps us to understand more about learning in many different contexts. How we learn on a sports field, in a science lab, on the farm, in a hair salon or on a building site is heavily influenced by the social situation and by the nature of the activity in which we are engaged. PVL, by contrast with general education, necessarily requires learners to experience different contexts, to understand and think like those who are expert in specific disciplines.

Communities of practice describe the kinds of social learning that such cultures require. Members of a community pursue a common interest and help each other as they do so. As they work and solve problems together, so their learning habits and attitudes rub off on each other. New members watch carefully how the more established members talk, respond and deal with challenges. Lave and Wenger have called this stage of joining a community 'legitimate peripheral participation'.

The noun 'practice' (in the phrase communities of practice) reminds us of the verb 'practise'. As we become part of a group or community we necessarily go through a kind of apprenticeship in which we gradually learn how to do something. To do this we practise with others, learning from those more skilled (closer to the 'centre' of the community) than ourselves in terms of their repertoires and insights. Practice also suggests that learning is a process, not an event; it takes time. The medical student slowly develops her clinical skill, and also gradually grows into the roles and identities she sees in her more senior or experienced colleagues – a process the French refer to as the *déformation professionelle*.

Learning here is much more in the relationship between people than in any one individual's head. Learning is to be found in the conversations and interactions of a community rather than somehow belonging to an individual. It follows that, for the successful development of expertise, PVL learners must, for example:

- acquire context-specific knowledge (where a particular piece of equipment is stored and how it is cleaned)
- gain adequate social confidence (having the courage to ask for help at different stages of a process)
- learn how to watch and wait until the moment is right to interrupt (the social sophistication of knowing who to ask and how).

In general school learners move from one curriculum area and classroom to another, but their structures and procedures are very similar. For most of those involved in PVE, however, there is the additional complexity that there will normally be at least two quite different contexts – school or college and some kind of actual or simulated working environment. Issues of learning transfer will clearly arise (which we discuss later in this chapter). In PVE there tends to be a greater variety of physical environments, different kinds of 'teachers' and, in many cases, more specialised equipment. Research in this area is still relatively undeveloped. New lines of enquiry are emerging that draw on fields such as sociocultural psychology, applied linguistics, social anthropology, social studies of science and organisational studies[7]. This more detailed kind of understanding of context and learning may yield real benefit. We think that those who organise the teaching of PVE would find this kind of detailed understanding of context helpful and suggest that more research could usefully be undertaken here.

'Members of a community pursue a common interest and help each other as they do so. As they work and solve problems together, so their learning habits and attitudes rub off on each other'

7. For a good exploration of these issues see the special edition of *Pedagogy, Culture & Society* (2007) Vol. 15, No 3 which draws on work undertaken within the TLRP in 2005–2006 exploring the relationship between learning and context

One researcher who has sought to tease out this kind of cultural detail is Chris Watkins[8]. He has taken the idea of a community of practice and explicitly applied it to schools and classrooms. Watkins is seeking to move away from the idea that 'learning = being taught' and explore the way in which a specific space – such as a classroom or studio or workshop – can be managed so that opportunities for learning are maximised. His research suggests that the way spaces are organised is a significant variable in terms of helping learning.[9] Taking this as his starting point he has sought to identify those elements of practice which are most beneficial for different kinds of learning. Watkins describes three stages in the development of learning communities:

1. Classrooms as communities
The teacher is building a sense of community in which students are actively engaged and have a chance to shape the way things are organised.

2. Classrooms as communities of learners
The spotlight is on learning (rather than on, say, teaching). There is likely to be an emphasis on students generating their own questions, high-levels of interaction between students and good levels of engagement.

3. Classrooms as learning communities
The emphasis is on the active creation of knowledge by all concerned, including the teacher. In such contexts learners not only take responsibility for themselves and their peers but also for what *needs* to be known. By the same token, learners are encouraged to see knowledge not as something that is static or even solely something that is what the teacher or lecturer has lots of but as something that they themselves can help to create.

Apprentices and other PVE students who engage in work-based learning, for example, form ready-made communities of inquiry; when they come together in classrooms and workshops there is the potential for teacher-facilitated rich discussion about their experiences in the workplace; and when they come together in the workshop, there is potential for peer learning (such as the opportunity to learn new techniques and different approaches to familiar techniques). We have not found any research as to how talk between apprentices and those engaged on vocational learning can best be facilitated.

At a more general level, Daniel Goleman has popularised some of the ideas we have been exploring under the name of 'social intelligence'[10] (in similar vein to his earlier writing about 'emotional intelligence'). Goleman's definition of social intelligence has two broad compartments, social awareness and social facility, each of which contains a number of more specific abilities.

1. Social awareness
- Primal empathy – picking up non-verbal signals
- Attunement – listening fully and receptively
- Empathic accuracy – understanding the thoughts, feelings and intentions of others
- Social cognition – knowing how social groups work.

2. Social facility
- Synchrony – smooth interacting at the non-verbal level
- Self-presentation – effective self-presentation
- Influence – shaping outcomes during a social interaction
- Concern – caring about the needs of others and acting accordingly.

These eight elements provide a useful focus for the sociable frame of mind one might be trying to cultivate in all PVL learners. Some of these components are implicitly present in PVE practice, although few workplaces are likely to be assessing the development of 'synchrony'! However, many expert crafts or trades people effortlessly display a smooth interaction between themselves and those working closely with them. While this component may be of obvious relevance in, say, Health and Social Care, it may seem, at first sight, to be less essential in engineering or construction. However, our contention is that such social dispositions are probably more important in all areas of PVE than they are currently given credit for.

One of the best-known and most detailed descriptions of social intelligence in action comes from the work of Edwin Hutchins[11]. Hutchins reports a detailed case study of the way in which a naval ship is navigated in and out of a harbour. He noted the extraordinary way in which tasks are intelligently shared among the different people on board. Two people take visual sightings. They call their readings out to two other sailors who, in turn, relay them by telephone to the bridge. Other people use specialised instruments and maps to plot the ship's progress and check on relative position to known landmarks. Thus a course is steered with a new set of data being relayed every few seconds.

No one individual could manage alone, because nobody is in possession of all the information needed – there is no individual 'in charge'. A

8. Chris Watkins (2005) Classrooms as learning communities: a review of research, *London Review of Education,* 3(1), 47–64

9. See also Margaret Wang et al (1990) What influences learning: a content analysis of review literature, *Journal of Educational Research,* 84(1), 30–43.

10. Daniel Goleman (2006) *Social Intelligence; the new science of human relationships*, London: Arrow Books.

11. Edwin Hutchins (1995) *Cognition in the wild*, Cambridge MA: MIT Press

sophisticated piece of problem-solving relies on each member of the team doing their bit at the right time, and passing their vital pieces of information on to the right person. It is not just that people are being intelligent and socially aware *in* a group; complex, intelligent action emerges from the coordinated efforts of the group itself. We suspect that this may be similar for an electrician working on a complex building site or an IT worker looking after the computer system of even a small organisation.

Learning cultures

Let's pause for a moment and look again at the 11 elements of our working 4-6-1 model, and ask ourselves what implications there might be for the design and management of the environments in which learning takes place.

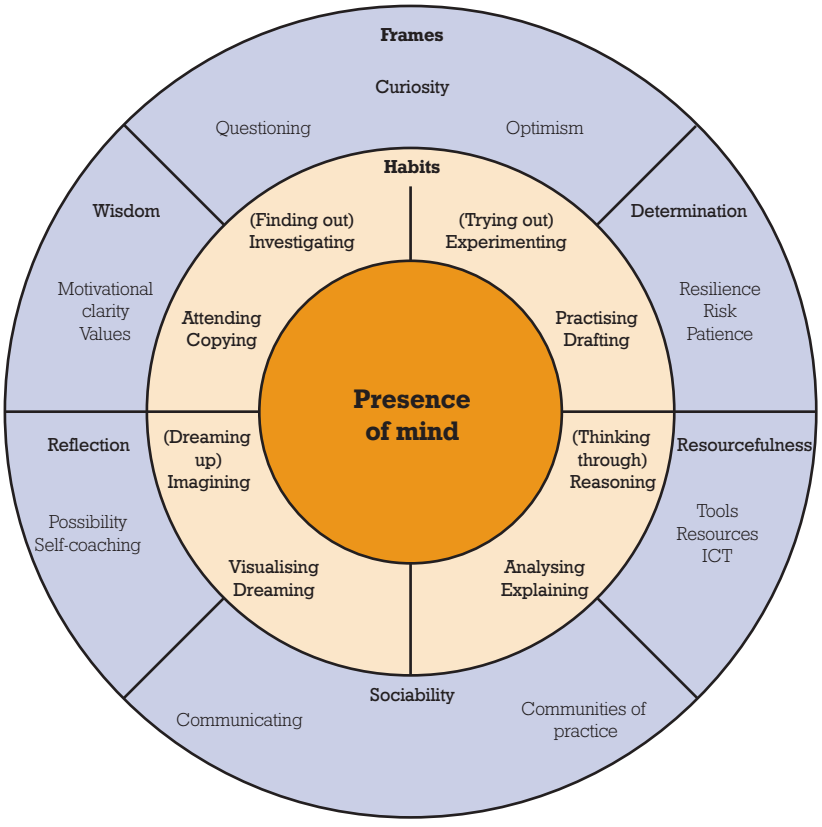
What kinds of cultures would seem to encourage and support the habits and frames of mind we have been exploring?

Let's take the habit of *experimentation* as an example. All PVL requires learners to try things out, practising difficult new processes and making tentative attempts with unfamiliar materials. What kind of contexts might be most hospitable to this kind of activity?

At the macro-level it will clearly be important for the PVE culture to encourage innovation and permit experimentation and, perhaps more importantly, not to frown on mistakes. For if learners are pushing back the boundaries of their knowledge, skill and experience, they are bound to err. Indeed this is where much of their learning will occur. Clearly, as Lave and Wenger have pointed out[12], some kinds of mistakes are costly or even potentially dangerous and cannot be allowed in a workplace. So, new apprentice tailors (in the example cited earlier) are not let loose on expensive cloth; instead they start at the end of the process and work backwards to the potentially more difficult and costly areas of

12. Jean Lave and Etienne Wenger (1991), op cit.

Figure 2 **The 4-6-1 model**



The culture and context of learning

learning such as cutting out patterns. In other cases the solution may be to create simulations of activities, something we described in more detail in our first report[13]. But as well as such practical decisions, there are also psychological ones such as the kind of mindset which vocational learners bring to their tasks. Learners with a growth mindset of the kind advocated by Carol Dweck (see the previous chapter) don't mind making mistakes as they see this as an important part of their learning. Those with more rigid views of their own abilities, however, tend to learn less from their errors because they stop noticing useful information and waste valuable time shoring up their self-esteem in the face of what they see as 'failure'.

At a practical level, spaces will need to be set up for work in progress to be left intact and critiqued by more expert others and there will need to be smaller spaces where conversations can occur. If resources allow, there may be some learning spaces with one-way mirrors or CCTV to facilitate unobtrusive observation by novices and expert alike of PVL in action.

Much of this kind of thinking about complex environments such as those encountered in workplaces and by PVE learners moving between, say college and the workplace, has been described by Yrjö Engeström in his work on learning by expanding, or 'expansive learning', already touched on in our first report[14]. Developing Vygotsky's ideas of socially mediated learning, Engeström is an advocate of what has become known as 'activity theory'. The core elements of this are well-summarised by Susan Bryant and colleagues[15] in a piece of research into an unpaid 'vocational' activity very much of our times – the collaborative production of Wikipedia. Bryant lists six important and interdependent elements of activity theory:

1. Object – the purpose of the activity system as a whole
2. Subject – a person or group engaged in the activities
3. Community – the social context; all the people involved
4. Division of labour – the balance of activities among different people and artifacts in the system
5. Tools – the artifacts (or concepts) used by people to accomplish tasks
6. Rules – the codes and guidelines for activities and behaviors in the system.

This kind of thinking is helpful in that it brings together the individual psychology of learners, social theories of learning and intelligence, and models of informal and tacit learning, with various ideas about apprenticeship (as well as connecting with the issue of learning transfer with which we end this chapter). In focusing on the artefacts used, the model is also particularly useful for PVE. In the UK, David Guile and Toni Griffiths have taken this kind of thinking one stage further.[16] They have developed what they call the 'connective model' of learning through work experience. Connective learning spaces are specifically designed to facilitate the development of learners by creating as many situations as possible in which learners will reflect on their experience. Such spaces require teachers or instructors to help learners to be able to draw upon both their formal learning (for example at college) *and* on the way their specific workplace is organised (its routines, processes and rules as well as its hierarchies) to understand more about their workplace learning. In such spaces experimentation will necessarily be endemic.

Spaces for other elements of the 4-6-1 model

In the last brief section we have been considering the ways in which experimentation might be encouraged by some specific elements of workplace culture. This exploration has allowed us at the same time to make links to thinking about expansive and connective environments more generally. We now want to move beyond the example of experimentation to consider the ways in which cultures and environments might be conducive to the other elements of our 4-6-1 working model of real-world learning. By 'cultures' we mean the values, beliefs and assumptions embedded in the social structures and practices of a community of practice. By 'environment' we mean the affordances of physical space and material resources.

In Table 1 on the next page we list some of the potential implications of our model for PVL. The examples are indicative only and in no way a systematic attempt to delineate the elements. Indeed we suggest that further research into this area would be potentially useful.

From Table 1 on the next page it is clear that there are some specific ways in which organisations can support those aspects of our working model for real-world learning or PVL. Our suggestions are very much a starting point. To go any further a level of empirical research is required which goes beyond the scope of this report. Other researchers have already begun to publish enquiries into the kinds of affordances offered by different working environments on which further work could build[17].

13. (2010) *Mind the Gap,* London: Edge

14. Yrjö Engeström (2000) Modes of Expanded Learning, Paper presented at *The International Conference on Teaching and Learning within Vocational and Occupational Education and Training*, Gottingen: Georg August University, September 21–24

15. Susan Bryant, Andrea Forte & Amy Bruckman (2005), Becoming Wikipedian: transformation of participation in a collaborative online encyclopedia, Proceedings of GROUP International Conference on Supporting Group Work, pp 1–10.

16. Toni Griffiths and David Guile (2003), A connective model of learning: implications for work process knowledge, European Educational Research Journal, 2(1), 56–73.

17. See, for example, Stephen Billet (2001) Learning throughout working life: Interdependencies at work, *Studies in Continuing Education*, 23(1), 119–35

Table 1 **Some Elements of a 4-6-1 Hospitable Workplace Culture**

Habit or Frame of Mind	*Examples*
Investigating	• Spaces specifically set up for demonstrating techniques • Cameras with play-back facilities for learners to analyse processes in more detail and at slower speeds • Learning structures which promote flow by enabling learners to spend longer chunks of time on projects • Opportunities for learners to work on extended projects over time
Experimenting	• Displays of work in progress with annotations of 'lessons learned' • Explicit attention to the teaching of different approaches to practising • Prototyping spaces • Spaces set up for specific scenarios • An emphasis on problem-finding as much as on problem-solving
Imagining	• Simulation spaces, including real-time scenarios • Spaces set up to facilitate different kinds of imagining – heavily visual, with models, with music etc. • Teaching the skills of mental rehearsal
Reasoning	• Intuitive and analytical thought processes encouraged and used • Feedback that encourages reasoning and p[romps further questioning • Use of models, metaphors and stories to share knowledge as well as more analytical thinking and writing
Curiosity	• 'Find out more' links in all learning materials and close to all production areas in the workplace • Daily challenges and posted on walls and screens to foster creativity • Graffiti spaces for questions to be posted
Determination	• Well-being and positive thinking programmes in widespread use • Strategies for bouncing back and recovering from setbacks; using failure or disappointment as opportunities for learning
Resourcefulness	• Prompt sheets, screens and posters promoting generically useful strategies • Easy access to a range of useful tools and/or materials to fashion implements when the need arises
Sociability	• Existence of vertical and horizontal quality and improvement groups • Processes of group work – e.g. opportunities for problem-solving in teams are recognised as valuable in themselves
Reflection	• Regular opportunities for many different groups to meet together • Reflective teams are comprised of stakeholders, each with differing perspectives on decision or events • All meetings and sessions end with a reflective conversation or written note
Wisdom	• An active attempt to tell the organisational story and hold on to the 'good elements', especially in periods of rapid change • Restore a culture where personal satisfaction is valued alongside objective achievement • Create opportunities to celebrate success and recognise 'good work'

Table 2 **Features of Learning Cultures**

Anti-learning	*Element*	*Pro-learning*
Ignored	*Success*	Celebrated
Cause of blame	*Mistakes*	Cause for reflection
Command and control	*Trust*	Empowered to act
Hide and deceive	*Openness*	Share and engage
Formal learning matters	*Knowledge*	Informal learning too
Resisted strongly	*Change*	Embraced willingly
Unwillingness to alter	*Routines*	Experimenting the norm
Always looking inwards for solutions	*Orientation*	Often outwards
Mainly directed	*Development*	Mainly self-chosen

In more general terms there is an extensive literature dating back some thirty years which relates to the features of an organisation which promote learning. The general term to describe this line of thinking is 'learning organisation'. Although Peter Senge is largely credited with first using the term in his seminal book[18] in 1990, it had in fact been widely used by Bob Garratt[19] a few years earlier. Peter Senge defines a learning organisation as one: 'where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together'.

Much thinking about the cultural dimension is necessarily aspirational, painting a picture of what might be, and often difficult to tie down in practice. Organisations, as Senge makes clear, are complex systems, and the flow of learning and knowledge around them is necessarily complex too. Yet change in this direction requires organisational adaptation at a very practical level. At every staff or shift change, for example, 'what have you learned from the last x hours?' could be a useful habit of questioning. Every time an apprentice or new employee joins, then a 'fresh pair of eyes' review can be initiated in which, one month in to their employment, the newcomer is invited to report what they are noticing about 'the way we do things round here'. And exit interviews whenever anyone moves on are useful tools for harvesting organisational learning.

In a paper commissioned for the NHS[20], Bill Lucas summarised research from many disciplines in the fields of organisational development and organisational culture, drawing out some key dimensions of learning along which learning cultures vary, as per Table 2, above.

These dimensions are not at all black and white. Take the example of what is called 'change' in the table. While potential openness to change is clearly desirable, and an essential aspect of the situational responsiveness that is sometimes necessary for survival and growth, it is also sometimes sensible to resist pressures to change (where it merely reflects unthinkingly jumping on a fashionable bandwagon, or where it undermines important cultural beliefs or values, for example). By the same token, while 'developmental thinking' may value the importance of self-direction, considerations of productivity or the need to master a new piece of equipment may require direction. The binary nature of the scale above is only a crude *aide memoire* for some aspects of learning cultures.

The informal nature of learning

As we made clear in our first report[21], research suggests that much learning in the workplace is informal. Informal learning refers to all the impromptu, unofficial, accidental learning that takes place as people go about their working lives. It involves watching, copying, trial and error, talking, listening, reading, practising, drawing, and often various kinds of feedback. Something happens for the second or third time and we begin to notice that a pattern is emerging. Gradually a hunch or a hypothesis begins to form in our minds without any external tutoring or even internal deliberation.

18. Peter Senge (1990) *The Fifth Discipline. The art and practice of the learning organization*, London: Random House

19. Bob Garratt (1987) *The Learning Organisation* London: Fontana Press

20. Bill Lucas (2006) *Creating learning cultures in the NHS, Inspiring ordinary people to perform extraordinarily well* London: Widening Participation in Learning Unit, NHS

21. Bill Lucas, Guy Claxton & Rob Webster (2010) *Mind the Gap,* London: Edge

Table 3 **Typology of informal (non-formal) learning** (Adapted from Michael Eraut)

	Implicit[24]	*Reactive*[25]	*Deliberative*
Past episode	Drawing on an experience in a session a year ago to help you now	Changing a technique because you suddenly recall another method	Keeping a learning log
Present experience	As you are speaking you remember a story which illustrates the point you are trying to make	Scribbling some notes during a meeting	Making a list of questions at the start of every session
Future behaviour	Choosing a way of doing something because of unconscious memory	Using a learning method you like when an opportunity arises, for example, making a mind map	Using a Personal Development Plan and setting personal goals

Recent research into one of the pro-learning dimensions listed in Table 2 – informal learning – is of particularly interest in understanding the environment of PVL. Research undertaken as part of the ESRC's Learning Society project has contributed to our understanding of the significance of informal learning. Professor Frank Coffield makes the point clearly: 'Informal learning should no longer be regarded as an inferior form of learning whose main purpose is to act as the precursor of formal learning; it needs to be seen as fundamental, necessary and valuable in its own right, at times directly relevant to employment and at other times not relevant at all.' [22] In other words, while formal input – teaching, tutoring, instruction – is important, informal learning in the kinds of expansive and connective workplaces we have been describing ensures that more learning sticks. The cultural milieu, in short, is as important as the explicit pedagogy.

There are many reasons why informal learning is undervalued, not least of which is precisely that it is not formal. It does not have a prescribed learning framework. There is no organised learning experience. There is no designated 'teacher'. It does not lead to the award of some kind of qualification. It carries no specification of learning outcomes. Informal learning is almost impossible to quality assure or to organise with the same kinds of dependability as formal learning. One of the best-known of a group of researchers interested in learning within the workplace, Michael Eraut[23], has developed a helpful typology of informal (or as he prefers to term it 'non-formal' learning. While his categorisations may seem slightly over precise about something like informal learning which is, of its essence, difficult to define, we find it helpful in promoting further reflection.

In Table 3 (above) we have adapted Eraut's thinking to map levels of intention against the timing of events which provide the focus ofor the learning. Simply by doing so, this helps us to see informal learning in terms of real-world activities. The implication of Eraut's thinking, it seems to us, is that in all aspects of PVL it is important to help learners become better at extracting the learning from their informal experiences. Many of Eraut's examples suggest specific learning tools (the learning log, for example, to deliberately extract meaning from past experiences, surely something that every practical or vocational learner might be undertaking, using a range of media from paper to web-based.)[26]

Applying each of the eleven elements of our 4-6-1 working model, may, we think, provide a further way of interrogating and valuing informal learning experiences. For each element provides a framework within which a certain kind of questioning can be set. So, in terms of experimentation, our earlier example, a learner might be asking questions such as: 'What happened last time I had to do something like this?'; 'How many different ways could I go about

'Informal learning involves watching, copying, trial and error, talking, listening, reading, practising, drawing, and often various kinds of feedback'

22. Frank Coffield (2000) *The Necessity of Informal Learning*, Bristol: The Policy Press

23. Adapted from Michael Eraut (2000) Non-formal learning, implicit learning and tacit knowledge in professional work, in Frank Coffield (2000) *The Necessity of Informal Learning*, Bristol: The Policy Press

24. Implicit learning is knowledge acquired without conscious attempts to learn or explicit knowledge of what was learned, see Arthur Reber (1993) *Implicit learning and tacit knowledge: an essay on the cognitive unconscious*. Oxford: Oxford University Press

25. Reactive learning, according to Michael Eraut, describes situations where the learning is explicit but spontaneous

26. For some people, this kind of reflection may be aided by writing, as Eraut suggests. For others, conversation, or even quiet solo thinking, might be preferable, or more effective.

tackling this?'; 'What would happen if I…?' and so on.

There are ways in which 'uncredited' forms of informal learning can be brought to bear in formal contexts. For example, skills of how to plan and prepare derived from home cooking or laying out a flowerbed, or designing and building a website can be useful. These can be solitary or group activities, and in either case there is no teacher present to guide or correct. Individual and groups of learners, instead, need to become confident at critiquing their contribution so that they can progress towards the desired outcome. The challenge when working in collaboration with others is to respond and act appropriately to informal learning in relation to the level of intent. In other words, participants in the group need to be alive to how they bring their own learning experiences to a given project and convey it to others. What may be implicit to one member of the group might require more deliberative 'surfacing' or structuring for another. These are important processes about which we believe there is not enough current debate within PVE.

Understanding learning transfer

When the learning from one context influences performance or experience of some subsequent task, then learning has been transferred. Sometimes this can be an improvement, as when a skill used in the workplace is successfully adapted for use at home. Other times it can be negative, as when failure to learn to do a task in one situation engenders a lack of confidence in a similar situation in other place. In many cases it is difficult to be sure about exactly where and when/how transfer has taken place, which makes a number of researchers understandably sceptical about the whole field of transfer[27]. Nevertheless as the process of transferring learning from one contest to another is so obviously relevant to PVE, we feel it deserves some further discussion.

For a century at least there has been a debate about how learning gets transferred. Two broad traditions have existed. The first suggests that for transfer to occur identical elements in the two situations are necessary, while the second argues that transfer can take place when general rules or theories are understood and applied[28]. More recently, theories have emerged that combine these two ideas. Gavriel Salomon and David Perkins distinguish between two kinds of transfer, which they call 'low road' and 'high road'.[29] Low road transfer occurs when a new context spontaneously reminds you of an earlier experience. A good example would be the first use of a new mobile phone. Although not identical to your last one, you easily transfer your knowledge of previous telephones and rapidly adjust to using your new one. A similar example would be driving a new car or even driving a small van when you are normally a car driver. The situation has enough clues and correspondences in it to prompt you to act in the right way. Your 'reading' of the new context is essentially a reflex reaction and largely non-conscious (although you may need to briefly stop to check your intuitive reactions).

High road transfer is different. It takes place when you more consciously seek to dredge up and apply things you have learned in contexts which may be quite different from the one you now find yourself in. Maybe you were taught to count to ten when you hurt yourself as a child (as a means of making it less likely that you would scream out in agony). Years later you find yourself sitting in a meeting and, infuriated by the wilful disagreeableness of a colleague, you are about to shout something rude at him when you become aware of an inner 'prompting' urging you to try something you have not used for many a long year. After a moment's thought you quietly start counting to ten and, after doing so, you find that your anger has subsided sufficiently for you to concentrate on the issue at hand and ignore your irritating colleague. Your inner coach has given you the *presence of mind* to save you from creating an embarrassing situation. As we suggested in chapter 3, presence of mind is where the learner and the learning situation meet, when the learner mobilises all the appropriate habits and frames of mind that they possess, some of which are prompted by the situation in which they find themselves, others of which arise unprompted in their mind's eye as result of earlier experiences.

High road transfer requires you to have extracted the essence of the learning from an earlier situation so that you can apply it. High road transfer involves two essential strategic learning skills, reflection and abstraction. In the meeting-room example, your inner voice has reflected that building in a short time-delay helps to defuse emotion and you have abstracted this into a rule of thumb 'count to ten'.

'Knowing when to immerse yourself and when to stand back and think requires knowledge, skill and lots of experience'

27. For a good example of this line of thinking see Douglas Detterman and Robert Sternberg (eds) (1993) *Transfer on trial; intelligence, cognition and instruction*, Norwood, NJ: Ablex.

28. For a useful summary of theories of transfer, see Leslie Keiler (2007) Students' explanation of their data handling: implications for transfer of learning, *International Journal of Science Education*, 29(2),151–172

29. Gavriel Salomon and David Perkins (1989) Rocky roads to transfer: rethinking mechanisms of a neglected phenomenon, *Educational Psychologist*, 24(2), 113–142

30. Leslie Keiler, op cit.

31. Ibid

32. One of David Perkins' seven principles for *Making Learning Whole* (in the 2009 book of the same title) is 'play out of town': 'The whole point of formal education is to prepare for other times and other places, not just to get better in the classroom' (p12)

33. Knud Illeris (2009) Transfer of learning in the learning society: how can the barriers between different spaces be surmounted, and how can the gap between learning inside and outside school be bridged? *International Journal of Lifelong Learning*, 28(2), 137–148

The distinction between low road and high road is much more than just a theoretical one as it has a direct influence on the way we teach in and beyond the classrooms of school and college and the varied spaces found in the workplace. Effective learners regularly use the low road method. They learn to do so through lots of varied practice in the original context so that they begin to recognise patterns and respond appropriately without having to think about it. The more difficult of the two – high road transfer – is mentally expensive and if we are absorbed in the flow of something such mental interruptions can easily distract us. These are subtle and complex issues. Knowing when to immerse yourself and when to stand back and think requires knowledge, skill and lots of experience. In practice high road transfer often takes the form of rules of thumb, thinking routines, instructions-to-self, good intentions, planning processes, heuristics and so on. In the workplace these may be 'top tips', guidelines, 'how tos' or specific instructions to be followed on every occasion.

Low road transfer is also somewhat easier to evidence than high road transfer, particularly when high road transfer is contingent on students' motivation to apply approaches to problems learnt in one context to problems in another. In terms of PVE we need, it would seem, much more explicitly to teach for transfer, at every stage of a learning experience coaching learners to think about possible applications of their learning in different contexts and situations.

Wherever possible we need to make the learning experience as similar as possible to their eventual applications. Simulations need to be plausible and life-like. Tutors may need to prime learners, setting them up to practise transferring what they have learned, in say, a week's time. Transfer may be helped by tutors' demonstrating what they are trying to teach rather than just describing it, all the while thinking out loud so that a trainee get a better idea of the thought processes of an expert in their specific vocational area.

Keiler's study in English secondary schools demonstrates that deliberate efforts to develop students' ability to transfer via the low road are effective, enabling them to bring knowledge of data handling (such as interpreting and creating graphs) acquired in mathematics lessons to science lessons[30]. However, instances of high road transfer were harder to elicit in this study, in part because students chose not to employ advanced statistical skills they possessed 'because they would not receive credit for doing the additional work'[31]. Therefore the demands of the assessment system can inhibit opportunities for learning transfer to take place. All PVE assessment systems need to be wary of any unintended consequences in terms of any inhibiting impact on the transfer of learning.

To make it more likely that high road transfer will occur, research suggests that PVE teachers and instructors need to:

- ensure learners practise in as many different contexts as possible (just as with low-road transfer but even more important here)[32]
- teach students how they might transfer what they are learning at the point when they first encounter it
- cultivate the pattern-making disposition of students to look for connections in all of their learning, helping them to see what is similar, what different.

We believe that schools and colleges are only just starting to understand the sophisticated processes involved in teaching students to get better at transferring their knowledge. And the role of the teacher is clearly key in enabling learning transfer to take place.

Cultures and contexts of learning and the idea of learning transfer come together usefully in the work of Danish researcher, Knud Illeris[33], for whom conceptualisations of learning environments as formal, informal and non-formal are too simplistic. He has instead developed a concept of 'learning spaces' and describes five main contexts in which learning takes place.

Everyday learning
The learning that takes in daily life in the spaces between specifically defined activities

School and educational learning
The intended learning that takes place inside formal educational system and institutions. It rational and externally directed

Workplace learning
The incidental learning which inevitably takes place as part of work and the more formalised

'We need to make the learning experience as similar as possible to their eventual applications. Simulations need to be plausible and life-like'

learning related to work and taking place inside or outside the workplace. This learning is accepted as relevant and meaningful when applied to the processes, tasks and production in the workplace, but limited beyond it

Interest-based learning
The learning which takes place in community activities, associations, and grassroots activities, or connected to personal interests and hobbies. One's motivation, convictions and enthusiasm for one's interests make this learning space very effective

Net-based learning
The learning to some degree independent of time and, to some extent, place. Learners express themselves in writing and so demands on articulation and terms of engagement are different compared with face-to-face conversation. As net-based learning is so new, we know very little about possible transfer problems connected with it.

Building on this, Illeris describes four different levels of transfer which offer a slightly finer-grained version of Salomon and Perkins' high road/low road transfer:

1. Cumulative learning
Applying repetition-oriented knowledge to uniform situations which replicate the learning situation

2. Assimilative learning
Applying knowledge oriented towards a certain subject in situations that foreground the subject in question

3. Accommodative learning
Applying understanding- or interpretation-oriented knowledge, flexibly applied within a broad range of relevant contexts

4. Transformative learning
Applying personality-integrated knowledge, freely making associations in subjectively relevant contexts.

Although there is a clear trajectory from cumulative to transformative learning, Illeris stresses that it is a mistake to interpret one level as being 'better' than another. Instead, each level can be seen as building on the one before. He argues that in practice it is important to develop learning activities that balance opportunities for and encourage assimilative, or additive, learning and accommodative, or transformative, learning. He cites collaborative work as being well suited to providing these opportunities.

In their research, fellow Scandinavians Konkola et al[34] argued that 'from the student's point of view, one's future workplace will inevitably be caught in developmental turmoil'. Thus, the best way to learn is to become engaged in real life processes of change while still in school. But where the 'master-novice relationship is becoming problematic… dialogical, collaborative problem-solving approaches' are preferred instead. They put forward the model of 'development transfer' which puts into practice Illeris's optimum mechanism and context theory, and present a case study from the field of occupational theory education. Hospital staff, the student, the teacher and a medical researcher were all recruited in a project that investigated the use of mirrors in rehabilitation of motor movement in stroke victims. The project team were drawn together in a 'learning studio' – a concrete space where they could work across the boundaries of school-based and work-based learning. 'The learning studio turned out to be an especially important locus of collaboration and collective learning for the [participants]' [35].

Project-based learning, of the kind that characterises cross-curricula learning in schools and the extended opportunities for (mostly) individual work in A Levels, Diplomas and the Welsh Baccalaureate, would be a suitable site for developing generic skills for completing a project. Therefore, each new project one undertakes could allow for reflection on previous experiences, and such reflection can span projects located in very different settings: the garden, the studio, the workplace or the classroom. Skills of planning from the outset, setting targets for success and managing time and resources are generic to project work, and so one's experiences of where particular approaches have been successful can be brought to mind when one starts afresh. Illeris concludes that if projects are the desired mechanism for effective learning transfer, then the desired context in which this occurs is an integration of school and workplace. He cites the apprenticeship model as a prime example of good practice in this regard.

An apprenticeship stretches a learner's capacity to transfer knowledge and skills by drawing on a growing stock of experience. From the classroom, to the workshop, to the workplace, the apprentice has different sites for learning, and how he/she brings prior knowledge and experience to bear in order to learn and understand new things can be conceptualised in two key ways. First, the knowledge-based approach characterises the knowledge and the contexts of acquisition that optimise the likelihood that knowledge can be

34. Riitta Konkola, Terttu Tuomi-Grohn, Pirio Lambert and Sten Ludvigson (2007) Promoting learning and transfer between school and the workplace, *Journal of Education and Work,* 20(3), 211–228

35. Ibid

transferred out from, or in to, instruction. Second, the person-centred approach considers how the properties of learners can affect the extent to which knowledge can be transferred out from, or in to, instruction. Let's expand and explain these two conceptualisations and see how they might apply to PVL.

Knowledge-based approach to learning transfer

For a practical learner, avoiding situations where what is learnt lies dormant in the learner's head are vital. New skills must be tested, experiments tried out, mistakes made and lessons learned in more applied ways than writing about how one *would* tackle a particular hypothetical problem in an exam or assignment. Wherever possible, learners should 'do it for real' or in simulated conditions. Working on realistic problems in real time, learners are more likely to be alive to the environmental or contextual cues that can trigger the recollection and application of stored knowledge at key moments[36]. For a carpenter, the likelihood that learning about types of mortise and tenon joints can successfully be *transferred out* from one context to another will be increased if he or she is actively looking for common features between situations and materials (e.g. the thickness of different timbers with which they have worked before). In this way, learners can help themselves to overcome the 'situatedness' of learning that often hampers successful transfer. They do not have to rely on the situation in which a skill or piece of knowledge was first learned to be replicated in order to bring it to use. And tutors can coach students to develop these kinds of attitudes.

Analogies can be useful in aiding the recovery and application of prior knowledge in learning new or abstract concepts[37]. For example, an ICT teacher might explain how a virus is spread over a computer network and how it is contained and resolved by making it analogous to the contagion and treatment of a biological virus among people in a small community. Teachers can also help learners to avoid negative transfer, which can occur when learners make errors in their extrapolation of what they have already learnt[38]. Analogies are useful, but they can also mislead. Superficial similarities may mask underlying differences. For example, in literacy, a primary school pupil may learn the grammar rule 'i before e except after c', but then fail to spell mathematical terms such as 'height' and 'weight' correctly when recalling this method. So the value of setting up simulated investigations for practical learners, to test the boundaries and limits of models and analogies in a safe environment, can be valuable learning experiences. This learning of limitations also applies to materials and processes, as well as ideas: learning what materials and processes *cannot* do can be as useful as learning what they *can* do.

Person-based approach to learning transfer

An enduring issue within education – and one that has become increasingly politicised – is the extent to which an understanding of Latin, Shakespeare's sonnets, or the lives of the Victorians makes for a more-rounded or successful learner. Do insights and attitudes learned in the context of such study transfer out of the classroom? There is no guarantee that the more one learns, the greater the likelihood that one can apply knowledge from this vast repository to new, and particularly practical, situations.

However, research has shown that the likelihood of such transfer can be increased by direct instruction. Ann Brown and Mary Jo Kane, for example, found that pre-school children who were given several lessons on transferring knowledge from samples to problems spontaneously began to transfer knowledge from one example to another on their own[39].

One effective way to enhance transfer might be to blur the boundaries between formal and informal contexts. This may be particularly advantageous for disaffected learners who are reluctant to adopt what they perceive to be a staid persona when in the classroom, in contrast to the 'street-wise' confident persona of their social worlds. As they have always done, successful teachers can particularly orientate practical and project-based work to the interests of those students who are least engaged.

Teachers alone cannot create learners who spontaneously transfer their knowledge or skills to tackle every new problem that may arise in all potential contexts, but they can help learners to

'New skills must be tested, experiments tried out, mistakes made and lessons learned in more applied ways than writing about how one *would* tackle a particular hypothetical problem in an exam or assignment'

36. John Bransford and Daniel Schwarz (2001) Rethinking Transfer: A Simple Proposal With Multiple Implications, *Review of Research in Education*, (3)24, 61–100

37. Mary Gick and Keith Holyoak (1980) Analogical problem solving, *Cognitive Psychology*, 12, 306–355; and Mary Gick and Keith Holyoak (1983) Schema induction and analogical transfer, *Cognitive Psychology*, 15, 1–38, cited in John Bransford and Daniel Schwarz, op cit.

38. Leslie Keiler, op cit

39. Ann Brown and Mary Jo Kane (1988) Preschool children can learn to transfer: Learning to learn and learning from example. *Cognitive Psychology*, 20, 493–523

develop the disposition to look for new applications of what they already know by thinking hard about the learning experiences they create.

Learner voice

Research suggests that when learners are engaged in shaping and leading their own learning and education there are benefits for learners, teachers, institutions and perceptions of the education system as a whole[40]. At the same time, systems and processes in which learners are passive run the risk of increasing disengagement and disillusion among those who switch off at the thought of 'traditional academic' learning.

In an age where the users of public services, such as health, are given a greater voice through charters and pledges[41], we might reasonably ask why the chief consumers of education – the students – are too often marginalised in decisions made about the provision they receive. The cultures of schools and colleges are only fully developed when they give learners not just a voice, but a chance to influence decision making and outcomes; after all, it is the latter that will have more impact in terms of learner participation at other levels (for example in the workshop and in the classroom).

While some educational institutions have adopted only a 'tokenistic' attitude towards student voice[42], others have given students an active and empowered level of responsibility in designing their educational experience. Some have successfully engaged students as researchers, working in conjunction with school staff to solve real problems that affect school improvement[43]. In terms of PVE, staff and students at one 13–18 Bedfordshire secondary school have completed enquiries into, among other things, improving careers awareness and guidance and what helps and hinders student learning[44].

Another way in which students are having a direct impact on the teaching and learning they receive is by being given some responsibility to observe and comment on teachers' lessons, rather like the role of an Ofsted inspector. One scheme – cleverly called 'Insted' – involved more than 100 students at a 14–19 school in Leicester observing about 200 lessons across all departments, and publishing their findings for the school leadership team[45]. The forums and processes through which learners' engage with what happens in their school are learning opportunities in themselves: how to conduct oneself in a meeting; or how to debate or present an argument convincingly. So regardless of the outcome, young people can derive much learning from the opportunity to engage in the democratic systems of the adult world.

Conclusions to Chapter 5

In this chapter we have put learning and learners back into the contexts of work and study, exploring the social and cultural elements of what is going on when vocational and practical education are taking place. The chapter looked at the way communities of practice operate, and considered the complexity of the social milieu in which much workplace learning takes place. In doing so we have articulated our belief that PVE systems need much more sophisticated descriptions of what is going on during workplace learning. Specifically we have sought to locate our emerging 4-6-1 model of real-world learning to environments and cultures to identify some of the possible features of a workplace culture that would be hospitable to PVL. We have set this in the context of much work over the last few decades about learning organisations.

The frames of mind of the effective learner, which we outlined in chapter 4, are effectively orientations towards the outside world. *Curiosity* makes one open to the novel and unusual. *Determination* enables one to maintain engagement with the world when it turns difficult or frustrating. *Resourcefulness* opens one up to all kinds of material and technological sources of support. *Sociability* couples learners to the immense resources of the social world, and enables learning to transcend the boundaries of individual knowledge and skill. *Reflection* enables learners to toggle between on-line engagement with the world and off-line opportunities to take stock and reappraise their approaches to the problem at hand. And *wisdom* connects motivation to perception, guiding learners towards challenges that are of real significance and value.

The milieu that is constructed by tutors and mentors either facilitates these forms of connection, or it inhibits them. It either encourages

'We might reasonably ask why the chief consumers of education – the students – are too often marginalised in decisions made about the provision they receive'

40. See special issue of *Forum: for promoting 3–19 comprehensive education on student voice*: (2001) 43(2)

41. For example, the Policing Pledge (www.direct.gov.uk/en/CrimeJusticeAndTheLaw/ThePolice/DG_181995) and NHS Choices (www.nhs.uk/choiceinthenhs/Pages/Choicehome.aspx)

42. Tim Rudd, Fiona Colligan and Rajay Naik (2006) *Learner voice: A handbook from Futurelab*, London: Futurelab

43. Jane McGregor (2005) *Development and enquiry programmes. Teacher researchers. Students as researchers*, Bedfordshire: National College of School Leadership; see also www.consultingpupils.co.uk/

44. Lousie Raymond (2001) Student involvement in school improvement: from data source to significant voice, *Forum: for promoting 3–19 comprehensive education on student voice,* 43(2), 58–61

45. Nick Morrison (2009) Right to be heard, published in the *Times Educational Supplement* Magazine, 23 January

these frames of mind to strengthen and deepen, or to become weakened and stunted. It stimulates students to look for opportunities to broaden the spheres of application of their developing knowledge and skill, or it neglects the issue of transfer, and just vainly hopes that, if students have somehow 'understood properly' what they were told in college, it should magically pop up wherever and whenever it might be needed in the real world of work.

We stressed the importance of problem-based and informal learning and began to explore the challenges which these practices pose to any educational system. At the same time we have outlined and analysed, in some detail, what the literature says about learning transfer, a line of thought which is largely missing in much planning of PVE. We think there is considerable scope here for PVL to be improved if some of these ideas are adopted. And we ended the chapter by raising the topical issue of student voice and student responsibility, and suggesting that PVE should continue to explore ways in which students can play more significant roles in the design and management of the learning experiences they are undergoing. We stressed the need for learners' views and perceptions to be taken more seriously within both learning and working environments, while recognising the practical challenges that this inevitably raises.

'PVE systems need much more sophisticated descriptions of what is going on during workplace learning.'

Chapter 6
Conclusions

Practising a vocation is as demanding of intelligence, ingenuity, flexibility and social grace as any profession. The kind of thinking that people do when they are making, fixing and designing things is as intricate and sophisticated as the work of a doctor or a solicitor. To treat the vocations otherwise has no basis in science, and no place in a 21st century society.

There are signs that, particularly in a time of global recession, some, maybe many, people are rediscovering the deep pleasure and dignity of working with their hands. At the same time, writers like Matthew Crawford are reminding us just how humdrum and repetitive much so-called 'brain-work' can be. The New Economics Foundation report (quoted in chapter 5) forces us to confront the extent to which financial rewards are unrelated either to the genuine social value or the mental demands of different kinds of work.

In this report we have joined the voice of the learning sciences to this rising chorus of doubt. As we saw in chapter 1, the enlightenment idea that Reason was somehow more quintessentially valuable, and more deeply 'human', than other kinds of thinking and learning, is now under deep scrutiny by science. Mind and body are aspects of a single, coherent, intelligent system, and the intelligence of the system cannot be understood without a deepening appreciation of just how essential is the physical body – especially, but by no means wholly, the brain. Human intelligence involves gestures, emotions, intuitions, and physical manipulation. The hierarchy that links abstraction to 'higher intelligence' is fast breaking down. And as this reappraisal of human nature continues, so the disparity of esteem between intellectual and manual forms of work is losing one of its principal justifications.

The aspect of this reappraisal on which we have focused here involves language: the vocabulary which we use to describe the kinds of learning and problem-solving that goes on in different occupations. We have not yet had a language of learning that gives voice, and does justice, to the kinds of intelligence displayed by the expert plumber, carer or gardener. In this report we have tried to develop a language for learning that is equally applicable to the worlds of trades and crafts as to the law court and the seminar room, and in doing so, to demonstrate their epistemic parity. The apprentice in the construction industry is using, and developing, powers of attention, concentration, imagination, mental simulation, experimentation and reasoning that are completely on a par with those in play in an A-level English or economics classroom. We think that this language, and the thinking behind it, makes a significant contribution to Edge's honourable mission.

We have also tried to show how a richer understanding of learning opens up interesting lines of enquiry about how to develop more engaging and effective forms of practical and vocational education. Some of these trains of thought echo and support developments that are already taking place. Students stretch their learning powers more when they are more engaged, and engagement increases when they are treated as partners in the educational enterprise, and given appropriate opportunities to contribute to the design of the learning processes they are undergoing. Engagement also increases when students are helped to see that the learning they are doing is intricate and demanding, and they are not 'at tech' because they lack the brain power to do anything 'better'. The skills they are learning are not intrinsically simpler than those of essay-writing, and the learning intelligence required to

The kind of thinking that people do when they are making, fixing and designing things is as intricate and sophisticated as the work of a doctor or a solicitor

master and develop those skills is itself complex and worthy of interest. Problem- and enquiry-based forms of learning are also as relevant to the BTEC beautician as to the medical or engineering student. Protracted, collaborative problem-solving, challenges that students and trainees can really get their teeth into, help them build the habits and frames of mind that are conducive to lifelong learning – and they do it better than does scribbling down lecture notes and mugging them up for a test. Our 4-6-1 model helps to underpin such sensible approaches to curriculum and pedagogical design.

But the model also opens up questions for PVE that are not so familiar. It spells out a second curriculum that shadows the more obvious one of domain-specific content and skills. Underneath the vocational learning lies the gradual cultivation of more generic habits, frames and presence of mind. As students are learning the safety procedures of the workshop, or the nature of the chemicals that colour hair, they are (or could be) also serving an apprenticeship in the craft of lifelong learning: learning new and stronger ways to attend, research, tinker, visualise, and – yes – think and reason. They are (or could be) developing their inclination to be curious and questioning, brave and determined, resourceful and ingenious, sociable and open-minded, reflective and self-aware, wise and strategic in their learning choices and challenges.

For many PVE students, these 'learning muscles' may be weak and narrowly focused. They may have lost faith in their very ability to learn. The opportunity exists for their tutors and mentors to help them develop their learning power and confidence – even more methodically and effectively than they already do. And a robust but accessible language for learning helps that project. The questions we raised at the conclusion of chapters 3 and 4, for example, can inspire novel and practical thinking that lead to the design of innovative educational environments and ways to teach. There are many examples of 'good practice', in this regard, throughout the tertiary sector of education. But they need a common rhetoric of learning if they are to scale up, and start to 'punch above their weight'.

From these habits and frames of mind spring confidence, pride and creativity. There are many young people who are curious and brave, resourceful and sociable, reflective and even wise, in their vocational lives. But there are also far too many who have not yet raised their heads, and sloughed off the cloak of second-rate-ness that has hung over those who prefer to speak with their hands and deeds and practical solutions, rather than with their pens and keyboards.

Tinkering with systems of management and accreditation does not get to the heart of this waste of talent. It is in the close-up milieu of engaging activities and inspiring examples that this battle will be won. We hope that this report, together with its companion, *Mind the Gap*, will provide some support and ammunition in this most timely and honourable of fights.

'In this report we have tried to develop a language for learning that is equally applicable to the worlds of trades and crafts as to the law court and the seminar room'

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Bodies of Knowledge

How the Learning Sciences could transform Practical and Vocational Education

The educational methods we have been using for the past 70 years are no longer fit for purpose. New scientific discoveries are challenging much of what we used to take for granted about the processes of learning and, most profoundly, giving us new understandings about the complexity and value of practical learning.

The new learning sciences described in this report offer a timely opportunity for educators and policy-makers to rethink some core educational principles and reconsider some established educational practices.

About the authors

Guy Claxton is Professor of the Learning Sciences and Co-Director of the Centre for Real-World Learning at the University of Winchester. Guy is a Fellow of the British Psychological Society and an Academician of the Academy of the Social Sciences. He is the creator of Building Learning Power and the author of many widely respected books on creativity, the mind and learning.

Bill Lucas is Professor of Learning and Co-Director of the Centre for Real-World Learning at the University of Winchester. Bill is also Chairman of the UK's Talent Foundation and a Patron of the Campaign for Learning (where, as Chief Executive, he led the first systematic research into learning to learn in English schools). He is the author of many books on learning, the mind and change.

Rob Webster is a researcher at the Centre for Real-World Learning. Prior to his study of practical and vocational learning, Rob has worked as a researcher at the London Institute of Education where his interests have centred on the role and impact of support staff in schools.

Edge

Centre for Real-World Learning at the University of Winchester