Effortless Mastery and the Jazz Metaphor

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Orthodox mathematics education emphasises conscious deliberative modes of knowing and learning, and neglects the constructive workings of the unconscious which are crucial for fluent and effortless mathematical know-how. This know-how, in part, results from a mindful attentiveness that is primarily unselfconscious, ethical and aesthetic. Effortless mastery is a mode of learning that leads to this know-how, and, in order to attain it, effortlessness must be a central focus of mathematics learning from the start. Effortless mastery also provides new insights into the phenomenon of 'maths anxiety'.

Background

This paper follows on from the papers I presented at MERGA2002 and 2003, and is another brick in the jazz metaphor wall. The jazz metaphor is a theoretical model that I am developing for an *ethical* approach to mathematics education. The jazz metaphor (Neyland, 2003) has six characteristics: (i) complexity (not complicatedness), (ii) an optimally minimal structure, (iii) the primacy of creative and spontaneous improvisation, (iv) challenging ('playing outside') established structures, (v) pursuit of ideals, and (vi) ethical know-how. All six characteristics are also those of jazz playing. The ethical approach to mathematics education, the therefore the jazz metaphor that is associated with it, has emerged from my ethical analysis of the problems inherent in *orthodox mathematics education* theory (Neyland, 2001, 2004a). Accordingly, the jazz metaphor is a presentation of a way of thinking and talking about mathematics education that avoids many of the language and cognitive constructs that characterise orthodoxy (see also Neyland, 2004b, 2004c). All six characteristics of the jazz metaphor are interdependent. What, in the title of this paper, I call *effortless mastery* (EM) is mainly associated with the sixth characteristic, *ethical know-how*, although, because the latter is also closely linked with the fifth characteristic, *pursuit of ideals*, this association is also significant. In what follows I will address EM only in relation to the sixth characteristic. Readers familiar with Neyland (2003) should note that what I called there, 'ways of the hand', I call here, 'ethical know-how'.

I introduced the idea of EM briefly during my paper presentation at MERGA2003. Those present responded by what was in effect a challenge to put these ideas into written form for MERGA2004. The present paper, then, describes EM in greater detail. EM is a mode of learning. It is, as I noted in the preceding paragraph, one that, by its nature, *runs against the grain of orthodoxy*. It is part of what Varela (1999, p. 7), and others, see as a "radical paradigm shift" emerging in cognitive science. Because of this it is likely to appear, at first sight, mysterious, muddled, or even fallacious. It certainly appeared that way to me when the idea of the EM of mathematics first came to me. I rejected it for more than a year. But the more I treated it dismissively as some sort of theoretical malformation or aberration, the more its truthfulness pressed itself upon me. I began to find more and more reasons to treat it seriously.

Then one day the fuller potential of the idea struck me. At the time I was working with a student who was experiencing something we have all come across in our teaching, 'maths anxiety'. Maths anxiety has proved problematic for mathematics educators. Is it mainly an *emotion* of fear, and therefore needing “treatment” by “systematic desensitisation” and “relaxation training”? Is it more an *attitude* of dislike, and therefore requiring a solution that involves finding new and more appealing ways to present mathematics? Is the problem primarily rooted in the Freudian *unconscious,* and therefore suitable for the methods of “depth psychology” (McLeod, 1992, pp. 584-585)? Are there “cognitive blocks” based on *misconceptions* about the nature of both mathematics and its learning (Frankenstein, 1989, p. 18)? No doubt each of the above plays some part. But is it possible that there is another factor not included in the above? Whatever the answer, the situation at the moment has been described as “murky”, and there is no adequate “theoretical foundation” for understanding this experience (McLeod, 1992, pp. 584-585).

Suddenly, when working with this ‘anxious’ student, it dawned on me that EM provides a new way of thinking about this phenomenon. First, EM is more or less the opposite of maths anxiety. This is a somewhat vague statement, but vagueness is all we have at this stage, and it may even be preferable to a misplaced exactitude. Second, EM is an approach to learning that is out of sync with the orthodox ways of dividing up the learning landscape. So, whatever its other merits, it would certainly have the virtue of being a fresh idea.

In this paper I will (i) outline what I mean by EM, (ii) show why it resonates with at least the sixth characteristic of the jazz metaphor, and (iii) explain why it is important for mathematics education. The second of these is particularly important. This is because *EM is not just another teaching trick or method*. It is part of a *whole ‘ethical’ orientation to mathematics teaching*. The part and the whole are one. For some readers this will be unfamiliar territory, so I will begin by summarising the key steps in the argument I am about to justify by reference to the literature. (1) Orthodoxy puts great emphasis on conscious deliberative modes of knowing and learning. The affective, attitudinal and unconscious are taken to be at best epiphenomenal and at worst detrimental. (2) But there is compelling evidence that the unconscious and the ‘undermind’ are crucially important for knowing. We might call this form of knowing ethical know-how. This does not entail a thoughtlessness, or passive ‘dopiness’, or acquiescence, but a new kind of mindful attentiveness. (3) This form of knowing is primarily effortless, ethical, aesthetic, even felt. Importantly, it is not rule oriented, formal, or procedural; that is, purely deliberative. It is partly deliberative. The deliberative works in consort with the effortless workings of the undermind. (4) EM is a mode of learning that leads to ethical know-how. (5) Most important, effortlessness must be a central focus of learning *from the start*. One has to learn how to be effortless. This takes time; and deliberative modes of learning work against it. (6) Ethical know-how and EM do not fit well with presentations of mathematics that emphasise its procedural and sequential nature. In fact, these could have the effect of disengaging the workings of the undermind. Instead, mathematics needs to be presented in a way that gives emphasis to, and allows access to, its ethical, aesthetic, felt and ideas-based qualities. (7) In addition, EM is an approach to learning that might well prove useful as we work towards a greater understanding of what is called ‘maths anxiety’.

Ethical Know-How as a Form of Knowing

One manifestation of this phenomenon is well-known to mathematicians. We all know the experience of a mathematical proof coming to us in the middle of the night. The Gestalt psychologist Köhler reports of physicists referring to the three Bs, where great discoveries are made: the Bus, the Bath, and the Bed (Nachmanovitch, 1990). The mathematician Poincaré was one who drew attention to it in mathematics. He was impressed by the way the unconscious provides a solution, unannounced, to a problem he had earlier been working on. But he stressed that such solutions still needed to be evaluated at the conscious level (Papert, 1980). Noddings describes it thus: "The mind remains . . . remarkably active . . . but instrumental striving is suspended. . . . We may sit down with our mathematics . . . because we want to achieve something . . . but if we are fortunate and willing, the goal drops away, and we are captured by the object itself" (cited in Claxton, 1998, p. 58). The mathematician George Spencer Brown claims that to "arrive at the simplest truth [requires] *not making an effort*. Not thinking. Simply bearing in mind what it is one needs to know" (cited in Claxton 1998, p. 58, emphasis added).

This form of knowing can validly be characterised as effortless. Some kind of effort is involved, but any effort is directed to a primary purpose which is effortlessness. Sudnow (1978), in an influential study, documented how it occurs in jazz. When the jazz musician is playing an improvised solo, it is her *hands that do the playing on their own*. They are not following directives from the conscious mind. The latter merely observes, sometimes with astonishment, the spontaneous music the hands create. One thing is crucially important here. *This is not the result of habit*. Musicians also know the superficially similar phenomenon of habit-like or automated playing. The hands can play a well-rehearsed piece in a reflex-like way while the conscious mind is miles away, planning the evening meal, for instance. This is habit. But the effortlessness described by Sudnow is different from this. Here the music created is being *newly created*. This is the sort of knowing that Varela (1999) refers to as *ethical know-how*. By "the ethics of know-how" he means "the spontaneous gestures that arise when one is not caught in . . . habitual patterns" (pp. 64, 69). Varela warns that these are not just mindless spontaneous expressions. They are "dependent on contingency and improvisation . . . Like a jam session, the environment inspires the neural 'music' of the cognitive system' (p. 55). The connection with jazz is immediately evident.

Reber, one of the first to do research into the role of the unconscious in learning wrote this: "I just never felt comfortable with the overt sequential struggles that characterised so much of standard learning". On the contrary, the most satisfactory learning seemed to occur "*in the absence of the effort to learn what was in fact learned*" (cited in Claxton, 1998, p. 26, emphasis added). Studies in neuroscience add support to this. The psychologist David Collins reports that sports people often go into a 'zone', a special kind of attentiveness. He recorded the brain wave patterns of a karate exponent before and during a difficult and dangerous breaking of blocks of ice with his bare hands. The warm up was characterised by the higher amplitude 'mountainous' β-waves of normal brain activity. Then, as he changed his focus of attention and moved into the 'zone' in which he remained until the break was completed, the brainwave pattern dramatically changed to another mode, the lower amplitude, flatter, α-waves. Claxton (1998, p. 149) reports similar findings from EEG readings of the brain activity of creative people working on a creative task. The "arousal level . . . was *lower* even than their baseline control readings". In addition to this, what we call 'fluency' in mathematics is, I believe, much the same phenomenon, only applied to mathematical activity more generally and not just to problem solving. Ethical know-how can also be thought of as the *intuitive* mode of knowing. Claxton (1998, p. 50) writes: "Intuitions are properly seen as 'good guesses' . . . thrown up by the undermind which deserve serious but not uncritical attention."

It is also clear from the research and from personal reports of competent performers that this sort of effortlessness requires that the knower draw back from self-consciousness, and instead maintain a special kind of attentiveness to the workings of the unconscious mind and the undermind. Frankl (1984, p. 141) has identified a more extreme way in which the self-conscious can interfere with knowing. He calls it "hyper-intention". But the more everyday workings of the self-conscious also prove disruptive. "The more self-conscious we are," Claxton (1998, p. 128) argues, "the more we shut down the undermind." People become "mentally clumsy, losing access to the subtler ways of knowing. Conversely, the less self-conscious we are, . . . the more we are able to open ourselves to the undermind." Such lack of self-consciousness is by no means easy to attain. The ego slips easily and subtly back into the frame. For instance, one can learn to stop being self-focussed in one's thoughts and shift to the sort of attentiveness discussed above. But then a tiny and self-defeating thought often then emerges, 'am I being sufficiently non-self-conscious?' In this instance the state of attentiveness is lost. Watzlawick (1984, p. 169) draws attention to just this when he quotes a Zen master: "To think/ that I will no longer think of you/ is still thinking of you./ Let me then try not to think/ that I will no longer think of you."

A crucial feature of ethical know-how is the *aesthetic* component. Claxton (1998, p. 57) cites the Nobel chemistry laureate Berg saying: "There is another aspect I would add to [intuition], and that is taste. Taste is almost the artistic sense." Claxton (1998, p. 155) also suggests that meanings that cross into the unconscious attain a certain "felt" quality. Conversely, as the focus of attention shifts more to the conscious, "knowledge becomes more intellectualised and less rich in meaning and feeling." Poincaré stresses the importance of the aesthetic in the workings of the undermind, and going further, he stresses the importance of the aesthetic for the study of mathematics. The distinguishing feature of the mathematical mind, he asserted, is not the logical but the aesthetic. He strongly challenged any separation of the cognitive from "considerations of affect, of feeling, of sense of beauty." The mathematician does not just "churn out logical consequences" but is "guided by an aesthetic sense." Mathematical activity moves from a deliberative mode of conscious analysis to unconscious work, to a period of "incubation" where the problem is "turned over to a very active unconscious." Subsequently the unconscious delivers back to the conscious the results of this activity. How is the unconscious guided in the timing of this return to consciousness? The criterion, Poincaré believed, is aesthetic. Of course, the findings of the unconscious still require a rigorous analysis by the deliberative conscious mind (Papert, 1980, p. 193-196). Papert acknowledges that what is true for an esteemed mathematician cannot be uncritically assumed true for others. However, his studies of ordinary people working on school level mathematics have led him to argue strongly in support of Poincaré's assessment of the importance of the aesthetic, not just for esteemed mathematicians, but for *all* learners of mathematics.

But, you might reply to the above, surely this notion that mathematical knowing is intimately linked with feelings of beauty and pleasure is just philosophical wishful thinking; mere speculative fantasy. Not so. Additional support for the critical importance of the aesthetic and felt modes of the unconscious mind in knowing can be found in recent neurophysiological research. Ramachandran and Hirstein (1997), for instance, in their study of the Capgras syndrome, show that if the connection between the visual 'face recognition' region in the inferotemporal cortex and the limbic 'emotional' region is cut (in an accident), subjects can fail to understand that successive appearances of the same person's face actually belong to the same person. They think they are merely different people who bear some resemblance to each other. While this neurophysiological research is not directly about mathematical learning, it is not hard to see that emotion and abstraction in mathematics could well be *necessarily* linked at the neurophysiological level in a similar way. This and similar findings from neurophysiology certainly give added plausibility to the phenomenological evidence provided by Papert and others.

Effortless Mastery as an Associated Mode of Learning

Ethical know-how, then, is a mode of *knowing* in mathematics (and elsewhere) that is characterised by the quality of *effortlessness*. It requires a particular type of non-self-consciousness; and it is not the same as habitual knowing. Effortless mastery is the name I give to the mode of *learning* that leads to ethical know-how. This mode leads to the *mastery* of mathematics, a mastery that is effortless, a mastery we also call ‘fluency with mathematics’. This assertion follows from the arguments of Poincaré and others cited above. How does one learn this effortless know-how? This is crucial. *The process of learning must also be effortless*. Effortless ethical know-how is not the result of effortful learning; although it is the result of a mode of learning that requires effort. One has to *learn to effortlessness from the start*. One cannot suddenly at the end of an effortful year’s study of mathematics—one that gave emphasis to merely conscious cognition, or what Claxon (1998) calls the deliberative-mode of cognition—become effortless in the way outlined above. In fact, such an effortful programme would result in it being harder to achieve effortlessness because one would have settled into routines of knowing that excluded the particular kind of attentiveness required for effortlessness. One could, perhaps, become effortlessly habitual, but I have already argued that *habitual know-how* is not *ethical know-how*. One’s learning of mathematics, if it is to achieve the qualities recommended by Poincaré, Papert, and others, needs to include the learning of an aesthetic and ethical mindfulness. From the first day, learning programmes need to prepare the learner to enter this ‘space’ or ‘zone’ or ‘flow’ of knowing, where ideas are moved from consciousness to the undermind and back, with ‘fluency’.

I use the term EM for reasons that will by now be obvious. I also use it for another reason. It sharply contrasts with another term used commonly in orthodox mathematics education: mastery learning. There are a number of reasons why these notions differ radically. One hinges on the understanding of practising skills. We all know that practice is crucial for successful learning in mathematics. The importance of practice is not disputed here. But there are different ways one can think about practice. There is one form of practice that is associated with Claxton’s deliberative-mode of thought. There is another form of practice that leads to ethical know-how. Because, as I noted above, what I am talking about runs against the grain of orthodoxy, it is not easy to adapt our familiar language conventions to make the sort of distinctions I need to put into words here. The closest I have found in the literature is Nachmanovitch’s (1990, p. 127) distinction between “practice” and “addiction”. The latter, he says, is like a ‘do-loop’ in computing. It is characterised by a “folding inward” and by a repetition of “sameness”. It “consumes energy” and leads to a kind of “slavery”. The former, by contrast, generates energy and leads to freedom. Thought becomes more and more “expansive”. More “implications” cross into the field of view and more “connections” become possible. It is characterised by a “challenging flow of work and play”. Varela (1999, p. 72) touches on the topic, too, but in a different way, when he writes: “. . . unlike mastery of an ordinary skill, mastery of the skilful means of ethical expertise results in the elimination of all habits so that the practitioner can [act] directly and spontaneously out of wisdom.”

Which Face of Mathematics is Appropriate?

Orthodox mathematics curricula place an emphasis on outcomes-driven, sequential mathematics. This, together with an associated increase in high-stakes testing, results in mathematics dominantly showing a logical, formalistic, and procedural face. The result is that mathematics is presented as reductionist and atomistic, and accordingly as ‘complicated’ rather than ‘complex’ (see Neyland (2004b) for this distinction). Papert (1980) views this sort of approach as “totally misguided”. “Mathematical aesthetics” today are treated as “an epiphenomenon” rather than “the driving force that makes mathematical thinking function.” The orthodox view privileges an “autonomous view of mathematics”. That is, mathematics as “self-contained, as justifying itself by formally defined (that is, mathematical) criteria of validity, and ignore all references of mathematics to anything outside itself, [including] beauty and pleasure” (pp. 192-193). His studies of non-mathematicians doing mathematics showed clear evidence of the aesthetic, felt, and pleasurable components referred to earlier. Among other things he found what he considered to be mathematical equivalents of ‘peek-a-boo’ figure/ground reversals, and punning, even in relation to the process of abstraction itself. He showed that gestalt (or ‘insight’) approaches in mathematics produced more aesthetic and felt responses than atomistic step-by-step approaches. His studies led him to call for the aesthetic dimension to be placed in the forefront of learning.

Procedural mathematics does not need the richer, more fluent, modes attendant with ethical know-how because it does not need an ethical or aesthetic component. It does not need a sense of what is of greater and lesser importance, a feeling for that larger and indefinable orienting purpose. This, of course, is circular. The orienting purpose cannot be *defined* because it cannot be reduced to the tiny realm of rational consciousness. But it can be *detected* and we can be *oriented* by it, just like the notion of ‘swing’ in jazz. Conversely, without the orientation provided by an horizon of significance, mathematical know-how becomes procedural (see Neyland, 2004b). Without this horizon, skill-practicing, because it is adrift from a larger sense of purpose, becomes mindless. The computer-like logical deduction of mathematically consistent truths does not require an undermind. Mathematical fluidity comes from drawing back from self-consciousness and allowing the mind to enter the ‘zone’ of poised attentiveness. But a mathematics that is merely complicated finds no need to drawn on creative and aesthetic modes of knowing. Proceduralism does not need the slow ripening, gestation or incubation of ideas. Using the termination introduced above, orthodox approaches encourage ‘addictive’ habits, not ‘wise’ practice.

Orthodox mathematics does not feed the intuitive mind. The intuitive mind requires the nourishment of ethically and aesthetically oriented play. Davis and Hersh (1981) give an excellent example of how active play can feed intuition. They show how one can develop a feeling for something as conceptually difficult as 4-dimensional space. They achieved this know-how by taking control of the movement of a computer model which represented 4-dimensional space 3-dimensionally on a 2-dimensional screen. It is evident from their description of this that the intuition thus developed led to an understanding not easily achieved formally.

In orthodox mathematics there is no need for play because there is nothing to play with, or within. In order to play one needs some sort of structure. Recall that, according to the jazz metaphor, improvisational play requires an optimally minimal structure. It also requires the ability to ‘play outside’. Proceduralism, because it has too much structure, stifles improvisation. For play, the mathematical face needed is one based on *ideas*. This notion of ideas-based mathematics, as distinct from a logicist or formalist mathematics, has been strongly recommended by Hersh (1986). More recently Lakoff and Nunez (2000) have shown that mathematical ideas or structures are imaginative projections from bodily and interactional experience. Mathematics develops by creative extensions from more basic structures. But such creative extensions cannot occur in the absence of some horizon of significance, because, without this, one would have no basis for choosing one extension over another.

More on Maths Anxiety

Nachmanovitch (1990) writes that there are five fears recognised in Buddhist philosophy that are ameliorated by a drawing back from self-consciousness and by attending to the workings of the undermind. The fifth is the fear of speaking in public. Nachmanovitch points out that modern equivalents are stage fright and writer's block. We could also add 'maths anxiety'. Claxton (1998, p. 123) argues that self-consciousness leads to "anxiety and apprehension", "constriction of attention", and the "coarsening" of responses. These could also be descriptions of the phenomenon we know as maths anxiety. A common approach to dealing with anxious students is to make it all easier for them in an attempt to reduce their fear. Making it easier typically involves more reductionism, more atomism, and smaller steps in the formal sequences. Effectively, this cuts off the undermind, and the aesthetic and felt components of mathematical know-how, and exacerbates the presence of self-conscious and deliberative thinking. In an effort to solve a problem, a solution is drawn from the same well of ideas that may have led to its cause.

There is a quite well-known experiment that was conducted by Held and Hein. Two kittens were presented with an identical visual field. One was allowed to be move around more or less at will, the other was not. The kittens were harnessed together in such a way that the movements of the active one resulted in precisely the same movement in the other. When the kittens were later decoupled the formerly active one moved with dexterity. But the passive one stumbled confusedly. Perhaps this is analogous to the situation with conscious and unconscious knowing. In deliberative, procedural and reductionist mathematics, consciousness is active, but the undermind is passive. This results, for some, in the mathematical equivalent of stumbling around in a disoriented fashion. The result, not surprisingly, is anxiety.

Optimal cognition, Nachmanovitch (1990, p. 93) argues, requires a "fluid balance between modes of mind that are effortful, purposeful, detailed and explicit on the one hand, and those that are playful, patient and implicit on the other." The art of mental gestation, he also writes, "depends particularly on the ability to turn on to the borderlands between consciousness and the unconscious [through a] gentle attentiveness to one's own mind" (p. 80). If these recommendations are taken seriously for anxious students, then the EM mode of learning, with its ideas-based, and ethically and aesthetically oriented modes would seem to be worth a try.

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