Keynote pedagogic imagination

When thinking about education we can get trapped in a circle of familiarity, staying unsuspectingly with what we already know. Even our radical attempts can remain stuck with the usual suspects that repeat the same critiques and provide the same answers. How can we think in ways that break us out of expected patterns and generate new alternatives?

In this address I am going to provide the elementary operating mechanisms of five techniques you can use to think about education in new ways.

\*The first technique works with a combinatorial logic to produce new options \*.

 At its simplest it has one variable with two possible states. Take, for example, the pedagogic variable ‘selection of knowledge’ and define two possible states – open or solid.\* By solid we mean only one selection is legitimate; by open we mean many selections are allowed. All this device then does is add more variables and states, with the instruction that you cannot forget the earlier variables and its states. It’s a naive device but the complexity it produces is exponential. To see this we can start adding on variables,\* lets say sequencing of knowledge, with two possible states, either one legitimate sequence or many possible sequences. \* It gives us four possible pedagogic spaces. Open selection can either have an open set of sequences added to it, or one solidly given sequence. Solid selection can also either have an open set of sequences or one closed sequence added to it. If we add to this set a third variable, \* lets say pacing of knowledge, \* that also has only two states, we have eight possible pedagogic spaces. Two possible states (open or solid) are multiplied three times (first by selection, then by sequencing, then by pacing).

The power of this device derives from the careful choice of variables and states. The pedagogic act must work with the selection, sequencing and pacing of knowledge. But we could add more variables\* – what of assessment and the relationship between teacher and student for example. This gives us five variables.\* Note that we would have to theorise and justify why the particular variables had been chosen and what the relationship between the variables are, but for the sake of this presentation I will work with obvious variables of pedagogy in analytical use and with simple states, as I want to provide you with this devices elementary functioning. If each of the five variables given above have only two possible states then we have 2^5, or 32 possible pedagogic spaces. It is also possible to imagine more than two states. We could start with a completely solid selection state, a state changing from solid to open, an open state, and a state changing from open to solid. Instead of two states we now have four states.\* Three variables, each with four states, produces 4^3, or 64 possible pedagogic spaces. \*Five variables, each with four states gives us 4^5 or one thousand and twenty four spaces. This device quickly becomes unmanageable for a single pedagogic imagination to handle, hence the need to keep the number of variables and states fairly low so that human imaginations can handle the variety. The other option is to shift towards computation, a process eminently possible with the above device.

This instrument of thought forces the pedagogic imagination to puzzle over the variations of pedagogic life and imagine spaces it had not thought carefully about before. We tend to get stuck with pedagogic extremes between radically open or progressive models of pedagogy and radically solid or traditional models of pedagogy. What of the rich varieties in between? To demonstrate this, lets take three variables of pedagogy (selection of knowledge, sequencing of what has been selected, pacing of what has been selected and sequenced); two possible states (solid or open); and force our imaginations to follow where the device insists we go. (4.25)

\* We already know the task that awaits us: we have to imagine 2 states to the power of 3 pedagogic variables, or 8 spaces in total.

\*Lets start with an extreme space where all three variables are solid – where only one selection is allowed, only one sequence, and only one pace. In South Africa we have the chorus model, where the teacher does only one thing in one way and gets the whole class going at the same pace by getting them to chant back responses. Why have we not worked on improving this model of pedagogy that most of our teachers have been brought up with? What international models are there that take this type of pedagogy seriously, experiment with it, improve it? Direct instruction, as developed by Engelmann in the USA, is like the chorus model, but its on pedagogic steroids. Enormous care is taken over selecting exactly the right knowledge, micro sequencing it so that every step is a small little jump in inference or action, each almost guaranteed to work because each micro step logically follows from the previous step. The students have to respond in unison to the teacher approximately 10 times a minute, producing an engaged energy across the class. This is a vital point to get, students are very active, precisely because no deviation from the script is allowed – there is only one way – the tested way that produced the results - and everyone has to do it, together and quickly, with the teacher giving quick feedback for both correct and incorrect responses. Many educationalists reject Direct Instruction out of hand. It is too scripted, too forced, too closed, it offers no freedom to the teacher, they say. As the presentation progresses we will take Direct Instruction as one of our guiding examples. Nothing sweeter than to use the pedagogic imagination on supposedly its ugliest daughter, and to find beauty.

\*The second possible pedagogic space allows openness in choice of selection, but once the selection is made then tightens both sequencing and pacing, providing one route and set times towards completion. Some PhD cohort models works with this possible pedagogic space, forcing the student to follow a set sequence in a set time but allowing choice over what the thesis topic is. \* Cohort models also use the third option, where the student is allowed an open selection frame to choose the topic, and also some freedom in pacing their study, but has to follow a specified sequence that moves through specific stages.

\*The fourth space allows both open selection and sequencing but then tightens the pacing, much like how teachers control open projects by giving set times for completion. \* It strikes a balance by offering the student freedom to choose what to do and how, but then puts the burner under them in terms of time. This is close to the fifth space, the most radically open of project spaces where freedom is allowed in the selection sequencing and pacing of the project, with the strong hope that such freedom brings self regulation and creative exploration.

\*The sixth possible pedagogic space strengthens the selection line, providing a set syllabus, but then allows freedom in both sequencing and pacing. These modular kinds of pedagogies have become increasingly popular due to online academies that provide a set of video lectures but allow the student to explore their own way through the lessons at their own time. These technologies of learning are becoming so sophisticated that they can now track the student’s performance in tests given at the end of various lessons and then suggest what is next in the sequence depending on how the student has performed, thus increasing the solidity of the sequencing line. (8.00)

\*The seventh space provides both a closed selection of what is in the lesson, and tight pacing requirements that pressurise the students to think quickly, but do not give any sequence, forcing the students to experiment with the given knowledge to get to a set end point in a given time. Problem solving lessons in Japan often follow this model.

\*Finally the eighth space is one much loved by Bernsteinians, where clear selection and sequencing of knowledge is given, but open pacing is allowed so that the student can spend time mastering the topic at hand. This provides working class students both with explicit content and sequencing so that they don’t have to wander around in the dark trying to guess what is important. But at the same time it gives them enough time to work through what is required so they develop understanding and can build upwards from solid foundations.

\*Each of these eight pedagogic spaces is special and should be treasured. Our pedagogic imaginations need to be able to work with what each of these possibilities bring and take away, so that, as experts in Pedagogy, we are not blind to the simple combinations thrown up by an exponential function s^n \* where s = the number of states and n = the number of variables.

With one demonstration behind us we can define the object of focus more clearly. By devices of the pedagogic imagination I mean instruments of thought that enable a rigorous breaking through into pedagogic possibilities not initially visualised by an educational specialist. ‘Device’ is purposefully chosen: the five instruments described in this address each have a specific, rule-governed way of functioning that produce, when artfully used, an inventive effect. Held together, they open out for inner play, the mother of devices, the Pedagogic Device. That’s a lot of device for one address! (10.00)

\*The second device of the pedagogic imagination works with levels. At its heart lies the modest request to take whatever pedagogic process or object is your focus and to ask what the levels above it and below it are. \* Name the level you are focussed on as L0 or the co-ordinate level, the level above it as L+1 or the super-ordinate level and the level below it as L-1 or the sub-ordinate level. How many levels can you go up and down without losing pedagogic purchase? In this question lies the artfulness of the device; it forces you to climb up and down pedagogic landscapes with the instruction that you stop when the levels lose their pedagogic reach. \* Plato used this device in his Cave Metaphor where a pilgrim travels from the cave of shadows to the light of abstract ideas, and finally into the idea of the Good; the ordering principle that gives ‘light’ to everything below it; \* Piaget told the story of our cognitive development from sensorimotor perception and pre-operational thinking, to concrete-operational to formal-operational thinking; \* Maslow’s Hierarchy of needs moved upwards from physiological needs to self-actualisation and, near the end of his life he broke through to a new level - self-transcendence; \* Bronfenbrenner showed us how to travel from micro, through meso, to exo and macro and combine them in chrono; \* Bloom gave us a taxonomy of learning domains that moved upwards from remembering and understanding to evaluating and creating; Gagné worked through learning hierarchies within Instructional design and Bernstein, as we shall see later, opened out the full range an educational message travels from its esoteric formulation in the sacred heights to its simple pedagogic expression in the practicalities of classroom life – a transformative trip he named the Pedagogic Device. (12.03)

Like the combinatorial device, this climbing device is deceptively simple. It can be used in very different terrains that range over spatial, social, political, psychological, instructional and organisational domains, some of which work with a spatial logic that goes from small to large, from part to whole, from micro to macro; others of which work in less tangible ways that shifts from concrete to abstract, from simple to complex, from particular to general.

The climbing device works inside the micro movements of a lesson. Where ever we start in a lesson (L0) a decision has to be made to either stay there and consolidate the point, to move upwards onto a higher and more difficult level that advances the student (L+1) or shifts downwards into more concrete and simpler elements to strengthen the foundation (L-1). Engelmann, the founder of Direct Instruction is a master of the climbing device. Whatever the topic, he firstly specialises himself in the domain, then he unpicks the elements to find elementary starting points. He then makes a micro move, either up, down or across, a small move, an obvious move that anyone who is rational and has understood the previous move can make. Then he makes another one, and another, each one unmistakeable in what it asks, but clear with the logical or evident answer. Then he tests the sequence on class after class, to see where the misunderstandings or lags are and refines the selection and sequence until the lesson works for everyone. Then he does the next lesson, building upwards until he has covered a topic or a skill, and even further, until he has a macro sequence that teaches children to read, or be numerate, or do calculus. It takes him years to develop and test a macro sequence, each day spent grappling with the smallest of steps moving up, down or across, until the highest peak is reached, and all that is underneath has been systematically mastered. (15.09)

It’s not only inside the lesson that the climbing device works its logic, it can also be used on the inside of our heads. \* We can move from the paper fibres a learner is writing on to the neuronal networks of the brain. \* If we simply work with physical scale that moves from small to large then we go from a synapse, \* to an individual neuron, \* to a neuronal network, \* to a cortical sub region, \* to the brain, \* to the central nervous system, \* to the body.\* This zooming in and out of the body does important things. It gets us out of a tendency to think that we are really just our brains, and the rest of our bodies are mere containers for its precious processes. Where it does not help is in the jump from the functioning of the material brain to the way our minds work, as this is a jump not in scale but in ontological type. Nor does it help us jump from a singular focus on the brain to the applied field of teaching and learning. The danger of developing an educational imagination stretching all over the show is that one can struggle to discriminate between the radically differing realities lying very close to each other in the actual processes of teaching and learning. An educational imagination has to learn how to recognise and negotiate boundaries, not just indiscriminately jump around between them. It helps to try and separate out different levels of analysis, correlate them, and work out what level speaks most strongly with an education voice. \* Take a look at the neural level on analysis on the left hand side and compare it to a behavioral level of analysis on the right. Its really the analytical levels on the right that are of interest to us, and I would like to show you why by working in and between the levels of ‘cognitive construct’ and ‘educational construct’. \* Examples of cognitive constructs are ‘working memory’ and ‘long term memory’. An ‘educational construct’works out the implications of these cognitive constructs for teaching and learning, and I will use Cognitive Load Theory to demonstrate how an educational construct works.

I only want to focus on two aspects of working memory, both of which, when properly used, expand its highly limited carrying capacity: firstly how visual and auditory processes can be used to increase its capacity; and secondly, how chunking turns limited capacity into massive carrying power. (18.00)

Working memory has two different channels that receive information – a visual channel and an auditory channel \* – and when both channels are used together, the capacity of working memory increases (Pavio 1986). If you listen to your teacher while at the same time seeing a demonstration on the board, you will understand more than either voice or visual on its own. I can testify to this effect from my own mathematical studies in the Khan Academy. Salman Khan has made around 4000 videos that he has downloaded onto the net for students to learn maths from addition and subtraction all the way through to calculus. If you watch a video you will not see him talking, you will see the maths problems being written out. You LISTEN to him talking whilst SEEING the maths problem unfold. This simple method, which teachers across the world use, makes the math easier to understand than simply working from the textbook or simply listening to an explanation. Videos that actually film a lecturer talking are wasting your working memory capacity. You don’t need to see someone talking, you need to hear them. But if, at the same time as hearing them, you watch examples, diagrams, figures, key phrases, then your capacity to understand and remember increases. This dual coding of information is also what makes power point presentations that simply put up what is being said boring. Your visual channel works at a different speed to your audio channel, resulting in an effect where you read the slide in a couple of seconds and then have to sit through the laborious verbal account of exactly the same thing. Don’t put up your words on a power-point, put up supporting images and diagrams. (19.45)

Even if you use both auditory and visual processors, working memory is still exceptionally limited in its carrying capacity. The memory span of young adults when pushed to its maximum is around seven items, as discovered by Miller (1956) in his famous paper “The magical number seven, plus or minus two: some limits on our capacity for processing information” Psychological Review 63 (2): 81-97). We know this from how we struggle to remember some-ones cell phone number. However, most of our learning tasks do not involve simple learning of bits, but of deciding what to do with a bit and relating it to other bits: is it right or wrong; up or down, inside or outside, here or there? Notice that this means we will remember a lot less than seven items, because our working memory has some of its space taken up with decision-making processes. This has resulted in various differences in what popular accounts say about the capacity of working memory, varying all the way from 7+/- 2 items, to one item on which a decision is being made. The more complex the decision to be made, the more working memory is taken up with the options presented by the decision. It is almost impossible to increase the amount of slots we have in working memory, so some other way has to be found to increase its carrying capacity. The answer to how this is possible can be seen by using an interesting chess experiment involving grandmasters, mid range players, and novices (DeGroot 1965). Each set of characters were given 2 to 10 seconds to memorize a chessboard position with 25 pieces. Grandmasters were astounding, recreating positions from scratch with 93% accuracy. Mid range players were able to get approximately half the pieces in the right place, and novices only a third. It would seem that grandmasters have photographic memories. I say ‘seem’ because if you take the same 25 chess pieces and put them randomly on the chessboard, then suddenly the grandmaster’s memory is only as good as the novice next to him. He was not remembering 25 individual pieces and their places, he was remembering patterns of pieces (Chase and Simon 1973). \* The thousands of hours spent playing and studying chess meant that the grandmaster was playing with patterns of patterns, each of which holds as one chunk. You can see this if you watch the grandmaster closely as he reconstructs the board from memory. First he thinks a little, and then places around 6 pieces down quickly. Then he thinks again before placing around another 6 down, and so on with the third set and fourth set. The setting down of the pieces occurs in bursts of patterns, not of individual pieces. The novice works with individual pieces rather than with patterns and so is really limited when doing this task. The grandmaster has developed an understanding of the connections between elements until a point is reached where the whole pattern is one functioning unit. As Whitehead would say ‘The many have become one, and increased by one’. This is what experts do. They don’t have more slots in their working memory than novices, it’s partly that they work with bigger chunks, and this makes it look like they have really quick, sharp minds. Suddenly, what seemed to be a terribly limited capacity can be expanded almost to infinity, not by increasing the number of slots in working memory, but by increasing the size and complexity of the chunk, and placing these into patterns of ever increasing size. It is the networked schemas you carry in your long term memory that gives your working memory real power. If you do not have these complex schemas in your long term memory, then you are doomed to working with around four tiny elements at a time, rather than with four huge processes. You can see this in the diagram with long term memory.\* Either you work with the tiny elements at the bottom, or with the massive chunks at the top that include the elements underneath them within their processes. The pedagogic question then arises – how do we increase schema construction in long term memory. It becomes pedagogically imperative to work on getting information into long term memory in an organised way. You can also see the resonance of this with how powerful knowledge structures work by continously building on earlier elements, not simply by adding more and more elements, but by organising the elements into patterns, parts into wholes, specifics into generalities, concrete examples into abstract principles. Bersteinians are permitted a brief smile. (25.00)

The place you build schemas is in working memory, so pedagogy must attend to the cognitive load expected of the student and ensure that working memory is not overwhelmed or starved. This is a tricky process because the more experienced the student is in the topic under exploration, the more developed hir schemas will be, meaning that more can be done, more quickly, especially if much of the underlying elements have been automated. If the student is a novice then care must be taken with the cognitive load as the carrying capacity of working memory will be limited. So, what pedagogic techniques can be used to reduce cognitive load by focussing on what is intrinsically necessary and eliminating elements that are extraneous? What can be cut away to make the load lighter but still keep what is crucial for understanding, meaning making, and the construction of schemas? Sweller, Van Merriënboer and Paas (1998) point out six pedagogic techniques that reduce extraneous cognitive load for novices:

Goal free effect: Don’t give the long term goal of the problem under exploration at the same time as the problem itself, rather focus on the problem and allow the goal to emerge once the problem has been understood. If you say what the goal is before doing the problem then the students have to try and work out the relationship between the problem and the goal BEFORE they have understood the problem.

Worked example effect: Don’t just give novice students a problem to solve, rather start with a worked example that shows what the steps of the problem are and how to solve it in its simplest form.

Completion problem effect: Once the students have been given a worked example provide a problem that has some of the steps already done and get the student to complete it. By reducing the size of the problem space to one or two steps that need completion you reduce extraneous load.

Split attention effect: Be careful of multiple sources of information that expect the student to integrate the different bits together. Rather provide one integrated source of information that the student can focus on.

Modality effect: If you are going to use different sources, then make sure that you combine the auditory with the visual channels. For example, replace a visual combination of a picture and a written explanation with a visual picture and an auditory explanation. Hopefully you will have found this one harder to understand because all of you were reading whilst I was talking.

Redundancy effect: Be careful of multiple sources of information that all do something similar. Rather have one source that does it all properly. (29.00)

The key reason why you want to free up some space for working memory is that it needs space to make sense of the problem at hand, to struggle with it, make meaning with it, so that the element of knowledge can be placed within an ever growing schematic set developing in long term memory. This process of meaning making also increases cognitive load, but it is a ‘germane’ cognitive load that results in the crucial shifting of information from the limited world of working memory into knowledge networked within the infinite world of long term memory (and held exterior to long term memory in the disciplines (and the better organised and explicit the structures of the discipline, the better for organisation in the head). It is this germane cognitive load that must be increased by cutting away elements of extraneous cognitive load, leaving only the intrinsic cognitive load to be worked with in a germane way. (30)

In effect, the total working memory capacity we have inside ourselves when doing a task is taken up by three different kinds of load: the intrinsic load of the task itself; the extraneous load of instructional choices around how to learn the task; and the germane load that comes with thinking about the task and making meaning from it.

It is at this level of focus that the educational imagination can feel the powerful contribution cognitive science makes to pedagogy. It has not gone into ever finer details about the chemical composition of the synapse, or the micro architecture of the brain, important as these levels of focus are. That is left for specialists in the neuro and cognitive sciences. What we have found in the work of Cognitive Load Theory, is a micro level of focus that has direct pedagogic purchase.

\* If the first device works with combining pedagogic variables and states, and the second with climbing through levels, the third works by taking two different elements and effecting a transformation that creates a new blend from their mixture. It’s a fundamental act of the pedagogic imagination, taking two different topics, or concepts, or ideas, and integrating them in a way that produces something transformed and illuminating. In South Africa, we are currently waking up to an outcomes based integration hangover, but over indulgence should not condemn the action itself, only its injudicious use.

\* By pedagogic integration I mean the process where two different zones are brought together in a way that recognises what is similar and different in them, allowing for an imaginative synthesis that brings out what is salient and leaves out what is minor, contradictory or confusing. Everyday experiences and contexts need to be conceptually integrated with school knowledge in such a way that what is striking and pertinent between these two zones is brought out for exploration, and what is minor and contradictory backgrounded. Different subjects can be placed in more integrated zones in such a way that teachers negotiate between subjects and transform them into themes and projects. At the heart of these expectances is pedagogic integration.

At its most elementary level two separate input spaces are needed along with cross-space mappings between them. The issue is that, depending on what kind of integration is sought, some links are more productive than others. \* We can use a simple example taken from a pictorial depiction of the changes of the Industrial Revolution. In a series of eight pictures it compresses what these changes were. \* If we take the first picture we can literally see the two input spaces of farming in 1750 and industry in 1900 quite clearly and start to make connections. \* Some connections are more worthwhile than others. To make a cross space mapping, you have to see a link between the two input elements, and this immediately generates a generic space that catches, in a general way, what the two elements hold in common. \* This generic space necessarily appears if a link is made and it captures what both elements jointly share. Birds and machine generically refer to the environment, smile and no smile refer to emotion, outside and inside refer to space, and so on. \* But this is not where the action of integration lies. \* A teacher who has a background frame of the industrial revolution can point to how the bird/machine link brings out a natural vs artificial theme, how the smile – no smile points to discontent; how outside – inside and walking – standing point to healthy vs unhealthy activities; how the plough – machine link shows the shift from man being in control to machine being in control.

\* That’s a lot of simplified information contained in one picture, never mind the other seven. What massive work of pedagogic transformation has this handout done. \* First, it’s taken the whole time period 1750–1900 and condensed it into two moments that are held together, making the effects of 150 years clear. Second, it has taken space and condensed the major shift from rural to urban areas into one picture. Third, it has taken all the multi-dimensional and massive complexity of change and condensed it to a small number of changes you can actually see. Fourth, it has taken the shifting nature of worker identity and reduced it to a change undergone by two individuals kept the same size and shape so you can see what has happened to him over the years in an instant. Fifth, all the causes and effects of the Industrial Revolution have been sharpened and dramatised by a simple before/after juxtaposition. Sixth, parts are used to symbolise whole processes, farming is displaced into a plough, industrialisation into a machine. The picture is working with time, space, change, identity, cause/effect, part/whole and compressing massively complex events and sequences into a digestible portion of elegant simplicity. (35.30) All of this is going on at a micro level. Its like taking a pedagogic microscope and focussing in on a border and finding, rather than a boundary that is either open or closed, sets of pathways running in and between, joining and separating, linking and delinking.

\* To fully realise the magnitude of the transformation, read any cutting edge journal article on the industrial revolution, \* absorb the complexity of its language, the nuance of its distinctions, the massive amounts of assumed knowledge needed to appreciate its moves, the years of ass numbing archival work, the continual reference, \* and then juxtapose it to the simple unsigned picture which has taken the esoteric production of new knowledge and twisted and transformed it into a pedagogic artefact a child can understand and work with. So many transformations must have happened to get from the production of new knowledge at the heights of the education system, to its recontextualisation, condensation and displacement into a single illustration found in a classroom on an overhead transparency.

\* At this point we can begin to glimpse how these three devices of the pedagogic imagination give us some insight into the inner workings of the Pedagogic Device. The pedagogic device is a transformative instrument of enormous power. \* It takes new esoteric knowledge generated at its peak point (level 1), \* recontextualizes it (at level 2) into teachable formats within its middle level, \* and finally, at its lowest point (level 3), teachers and students engage in the hard yards of ensuring the recontextualised knowledge is learnt. Bernstein climbed up and down this educational terrain and came back with a map for us that clearly indicates its highest and lowest levels as well as those in between, and the key borderlands abutting the device \* (like the primary contextualising context of the family and community that forms the grounding from which the pedagogic device takes its subjects, \* and the fields of the economy, \* symbolic control and \* international field that strongly influence the device). It’s a hierarchical model, the highest point informs what happens below it, the lowest levels provide the foundation without which the highest would not reproduce itself. It does something else as well, it draws a line where pedagogy is relevant and where it is not.

Work the pedagogic imagination through the levels. If we start at the highest point (the international field) we have the largest and most widespread level. Note that it is also the level where new knowledge is produced. This reduces in size to the field of the state. \* Within the state, we find the recontextualizing field concretised in the Department of Education that produces the official curriculum, and the higher education institutions that produce the teachers able to teach this curriculum. It is also the level where the new or esoteric production of knowledge is recontextualised into teachable forms. \* Narrowing our focus even further we enter the world of the classroom, with its teachers grappling with the task of teaching learners how to digest the whole accumulated history of knowledge in twelve years, no matter who the child is or where she comes from. As we made these moves through the levels, was it mainly the scale of focus that shifted from macro to meso to micro or was it the shift from complex to simple, the shift from abstract to concrete, the shift in organizational levels? In the labour of the Pedagogic Device to transform the esoteric into the learnable, it works with levels that go from macro to micro, from complex to simple, and from abstract to concrete. (40)

Secondly, we note that it’s not only levels that the Pedagogic Device works with. How is it possible to learn what has taken the accumulated labour of the brightest of our human species thousands of years to work out? We have produced, and are producing enormous amounts of new knowledge. How can we condense it all into 12 years of learning? Well, hindsight helps a little. What took literally ages to work out, like the number system and letter system, is now grist for our grade ones and twos. \* From the solar system to the atom, we have worked out the intricacies and can present it in simplified form for our young ones to learn. We even use our planetary system as an input space to help our kids understand the inner working of the atom. The Pedagogic Device has, at the heart of its operations, a transformation tool of enormous power, one that works at continually blending input spaces in ways that reduce the massive realms of knowledge into humanly understandable dimensions. And we need this second tool of the pedagogic imagination really badly. Our knowledge is growing at a rapid rate, meaning that more and more has to be condensed earlier and earlier.

\* Thirdly, we note that it is pedagogic discourse running through the pedagogic device. \* At its simplest, Pedagogic Discourse consists in manipulating the states of key variables of pedagogy, what Bernstein calls classification and framing. Wait a second, that’s what we spent the first quarter of this presentation discussing with the combinatorial device. We have already looked at a version of pedagogic discourse using three variables (selection, sequencing, and pacing) and two states (open or solid), and explored the possible spaces these combinations produced.

\* Step back for a second and contemplate the beauty of this: of how three devices of the pedagogic imagination (combining variables and states, climbing levels, and transforming knowledge into digestible portions) come together in a systematic vision of the pedagogic device. Only for a second - we have left something crucial out, \* a key device of the pedagogic imagination that bears down on the other three with a structuring force, caught by Bernstein in the GRD or general regulative discourse, by which he means the dominant values of society that provide the deep guiding principles informing how we instruct. What and how we teach is always embedded in the values we live by and aspire to, symbolised in the formulation id/rd – instructional discourse is embedded in regulative discourse.\* (45)

Half Time

We can illustrate how profoundly important the regulative is through a negative parable - the sad tale of the failure of Direct Instruction in the USA.

As previously pointed out, “Direct Instruction” is a way of teaching that works with strongly scripted and sequenced lessons that insist on active responses from students every seven seconds or so; and a continual focus on building new skills on old, resulting in mastery. The lessons are field tested to ensure they work. Direct Instruction hit the big time when it participated as one of the methods to be extensively trialled in Project Follow Through – the largest and most expensive experiment in education ever funded by the USA government. Throughout the 1970’s and 80’s, controlled comparative studies of teaching methods were conducted, aimed at experimentally working out which methods genuinely worked for disadvantaged communities across the USA. \* Direct Instruction won hands down in reading, Maths, spelling and language in comparison to all other methods. The table clearly shows this, with the highly structured instructional models strongly outperforming more open and progressive models or models that emphasized problem solving skills and enhancing self-esteem. Did this result in Direct Instruction suddenly becoming the pedagogy of choice across America? Not a chance. Its scripted demands where teachers have to follow the steps exactly, and where students are all doing the same thing, without any variation, goes directly against the most deeply held values of American life that revolve around freedom, choice and individualism. Direct Instruction as an instructional discourse might work, but the regulative discourse it carries deep within its practices are hard for many Americans, and others, to swallow. (47.00)

This provides us with some reasons why Direct Instruction did not become one of the dominant pedagogic discourses in the USA, but the same reasoning does not hold in South Africa within our more traditional cultural practices and beliefs. Guthrie has pointed out that African cultures, with more revelatory epistemologies where ancestors and deities are worshipped and respect for elders is core, have a strong preference for more traditional teacher based, knowledge centric pedagogy. Is there not some resonance here between the regulating principles of traditional cultures and formal instructional strategies, and might formal modes be a better option than progressive modes of pedagogy where selection, sequencing and pacing of knowledge are more open. Guthrie asks why there has not been more experimentation with the varieties of formal pedagogies known to be effective instead of continuously attempting to replace formalist with progressive pedagogic practices across the developing world. Why do we not know more about the inner workings of Direct Instruction and other formalist models more suited, both in instructional and regulative terms, to a traditional context? \* The chorus model is a classically closed model, where the teacher as conductor directs, and the learners as choir sing. But that’s not the image that dominates in my experience. \* More dismissive terms like ‘jug and mug’, or ‘banking education’ dominate, where information is poured into poor students heads in the interests of monopoly capitalism.

But we cannot allow our pedagogic imaginations to be stuck with one or two regulative discourses, just as we cannot allow ourselves to only imagine one or two instructional discourses. There are more than one set of guiding principles in education, and just as we have learnt how to work with different instructional combinations, clamber up and down levels, twist and transform, we also have to learn how to make judgements between competing principles that justify what is educationally sound. To some extent we all have this ability to judge between conflicting principles, growing up in a modern world forces it on us. \* As children we were immersed in a world we simply accepted, \* as teenagers we separated ourselves from this world, rebelled from it, but without much understanding of what else was on offer. \* But as adults, we come to a working understanding of different orders of worth and we work between their differing ethical demands, depending on the situation at hand. When disputes arise around a key education issue, it is often impossible to simply compare evidence and go with whoever has the best proof. Different ethical stances on the world take different kinds of proof more or less seriously. A person who feels that caring for children is the informing principle of education will struggle to compare evidence with a person who feels that specialization is key. In a dispute over a pedagogic issue, both the ‘carer’ and the ‘specializer’ will have to search for some common ground, some compromise, some kind of test of worthiness both can agree on, and do this in a space where their highest ordering principles are inconsistent. And it is here, in the space of dispute between two ethically informed peers, each of whom feels deeply that their own ordering principle is best, but at the same time also search for some form of dialogue between colleagues, that the pedagogic imagination is needed. Justifications and critiques must be conducted in diplomatic ways that negotiate between competing principles of worth. (6.50)

I choose the adverb ‘diplomatic’ carefully. Its dangerous terrain. The principles that inform what we do are precious to us, and principles, by definition, tend to have a universalising impetus. If you believe in being creative in education, for example, then you will tend to believe that all children have creative energies deep inside, that creativity is vital to pedagogy, and even more universally, that creativity makes the world a better place for all of us. When such a set of principles clashes with a more traditional set that points to the need for order, routine, and respect, the disgust and horror felt by each set of protagonists for the other is compounded by how each feels the other is harming the very essence of the learner, and even worse, threatening the very existence of goodness in the world for all of us. It’s the same with those who argue for generic skills. The market is changing very quickly, new technologies and innovations make rich traditions and specialised skills obsolete. How can we not prepare our children for such a world, how can we not square up to the reality that flexibility and adaptability will be key to our children’s futures, how can we not make generic skills the informing principle of how we prepare our students for the future?

Like the other three devices, this justificatory device has a deceptively simple set of working mechanisms. Let us start with the basic structure of how a pedagogic principle of worth operates.

Firstly, all those undergoing a pedagogic process must have some basis of equality that is being aimed at, something all of them will share, some kind of common humanity.\* We educate our children in order for them to become something - but what is it that they should become? Good citizens? Specialised workers? Creative and independent thinkers? Caring and loving human beings? Generically skilled life long learners? All of these, some of these? Something else? Depending what is taken as a common aiming point, different ‘regulative’ worlds arise that justify different ways of educating. But it is not only an end point to the pedagogic process that defines a common humanity, it is also something we all carry deep inside of us. For some it is ‘reason’ that all learners have in common, for others it is a need to be loved and to love, for yet a third it is a need for order and security in routines and traditions, and for a fourth it is a creative spirit deep inside. You can recognise these claims when someone says something like this: ‘all kids, no matter who they are, can reason’ or ‘all children need to be loved’, or ‘all students need a sense of boundaries and rules’, or ‘all learners are creative explorers at heart’.

As important as the claim to common humanity is, there is the hard reality that learners, both during the process and at the end of their schooling, are at very different levels.\* All learners can reason, but some reach higher levels of reasoning than others; all students are creative at their core, but some students reach higher levels of creativity than others. The key claim a regulating principle has to make at this point is that all students can access its own particular highest level. The creativity burning inside of you will allow you to scale the heights of creativity, just as reason, embedded deep within you, will allow you to reach the heights of reason. All can access all states, including the highest. We have, in Boltanski’s terms, a common dignity. The obvious question then arises - why are all our students not at the highest level? At this point three explanations can be given. The first simply points to processes of development. Children are in process: for example, as Piaget showed us, their reason is developing from pre to concrete to formal operational. The second explanation is that something is holding them back, and that something could be social injustices, or poor pedagogic practices. The third explanation is that some students have sacrificed more than others, they have worked harder to reach higher. Popularly known as the 10 000 hour rule – it takes sustained investment of time and effort to reach the highest levels. All might be able to reach the peaks, but only some do, because they are prepared to sacrifice other pleasures in the quest to reach the heights (or because their parents paid for it). The reasons why not everyone makes it to the top have to do with a complex interplay of factors relating to social justice, stages of development and sheer determination of will to invest yourself in practices that will get you to the top. 12.30)

But the tops are different as are the strategies to get there. The investment practices and sacrifices made to become more caring are different to those that result in becoming more specialised, or more creative, or more generically skilled. And it is at this point a key move is made that gives real power to a regulating order of worth: it is claimed that the ordering principle - even though it results in differentiation with some at the top and some at the bottom - is good for everyone.\* It is for the common good that we have creativity as the regulating principle; it produces a world that is better for everyone, whether you are highly creative or not. All will benefit from its creative energies. It is for the common good that we have generic skills as the ordering principle; it provides everyone with the chance and flexibility to work in the new modes of production sweeping through the world. It is for the common good that we have critically minded citizens for, at the heart of a good world, is a fully functioning democracy. It is the coup de grace that allows an ordering principle to step above its seemingly located and limited focus and stretch outwards to claim the whole world will be a better place if the principle is applied.

How does this world of competing regulative orders of worth become a device of the pedagogic imagination? Remember the definition right at the beginning: the device must have a specific, rule-governed way of functioning that produces, when artfully used, an inventive effect. It should be an instrument of thought that enables a rigorous breaking through into pedagogic possibilities not initially visualised by an educational specialist. We have outlined the basic structure of a regulative order of worth in how it shifts from a common humanity, through to common dignity, and then finally into the common good. But it is how these different regulative orders of worth come into dialogue with each other that the pedagogic imagination begins to play. Lets take three orders of worth used as examples above (traditionalism, creativity, and generic skills for the market) and place them into a combinatorial matrix where they can either be in a state of alliance or critique with the other orders. 15.16)

And what does the combinatorial matrix do? It forces us to think through the possible regulative spaces of combination. We can start with all three regulative orders being in conflict with each other (xxx) and no possibility of an alliance. Creativity as a principle would accuse generic skills of prostituting the true creative urge to the highest bidder on the market, and accuse traditionalism of destroying the creative urge through routine and habit. Generic skills would accuse a single minded creative urge of not being opportunistic enough, of being too indulgent and overly risky rather than taking advantage of current circumstances. It would accuse traditionalism of being naïve, restrictive, inflexible and outdated. Traditionalism would accuse Creativity of over indulgence, chaos, and disrespect, and generic skills as lacking substance and backbone.

 If we take a regulative possibility space where all three are in alliance with each other, a very different set opens out.

Creativity would argue that the generic skills environment provides a genuine space for innovative energies to thrive as different and new projects continually demand inventive problem solving. It would open out to traditionalism for the continuous practice and routine it offers, providing the creative with an automated set of skills that do not need to be thought of, thus releasing the mind to work creatively. For example, a creative dancer first has to master the dance moves with continued repetition and discipline, do them without thinking so that her mind and body can sweep outwards rather than stay caught in the technicalities of the actual movement.

Generic skills eyes would light up at creativity and label it as one of its most important flexible skills, and so we could continue, with the combinatorial device forcing the pedagogic imagination into regulative spaces it had not thought of before where differing regulative principles come into conflict and compromise.

Notice, that in order to comparatively work with three regulative spaces, we are also using the transformative device.\* We take one regulative principle as an input space, and another regulative principle as the second input space. Then we look for cross border mappings, paying attention to either those links that connect or those that don’t, or both.

And whilst doing all of this, inside each regulatory principle we listen for its own levels – the levels inside reason, the levels inside care, the levels inside skills. Each has its own climbing device.\* Inside the ethics of care, for example, we know from Gilligan, there are stages of moral development moving up levels from pre conventional to conventional and post conventional.20)

Lets rest for a moment and look back over where we have travelled and the tools we have used to do so, if only so that we can look forward again to the task ahead. Like a pilgrim breaking through to another world, we have opened out the possibilities and potentials beyond the instantiations of the given world. Its not that we don’t work with what is given to us in education, its that we play with it: either by combining its variables and states; climbing through the heights and depths of its levels; transforming its elements into something new; and negotiating diplomatically between alternative regulative worlds that inform the very shape and forms we use to educate. The juxtapostion of Direct Instruction to more progressive pedagogies has helped us generate a linking thread through the journey, now, as we reach the end point, I would like to turn around and show how to hold these two pedagogies together as expressions of deeper forces at play.

If we go back to the combinatorial matrix,\* direct instruction and progressive pedagogy sit on opposite poles to each other. Its useful to break down a simple oppostion between the two by showing other pedagogic combinations, but the use of open and closed lines makes us think discretely in terms of binary bits rather than flows or curves. I am a great supporter of using binary, as the first device of the pedagogic immagination demonstrates, but what I would like to do is take you into how the pedagogic imagination works with curves rather than with bits.\* 22)

We generated the juxtaposition of direct instruction and progressive pedagogy by using an open/closed distinction that has as its inspiration Bernsteinain code theory. It hones in on how much control the teacher allows students in terms of the selection, sequencing and pacing of knowledge. I would like to shift focus from ‘who is in control’ of sequencing and pacing to how ‘heavy’ or hard the sequence is, how fast the pace is, and work with the dynamic on a cartesian plane. \* If we place weight of sequence on the y axis and speed of pace on the x axis we get a simple graph that goes from light to heavy, and from slow to fast. What I like about this set up is it places two different pedagogic variables into productive tension, producing a highly simplifed field that is astonishingly fertile.\* Four basic zones are generated: \* light and slow; \* heavy and slow; \* light and fast; and \*heavy and fast. The tension between these two variables makes sense. \* A novice works lightly and slowly – a simple task can take a while. \* An expert works with heavy and complex problems quickly. We saw this in the difference between a novice chess player and a grandmaster, where the novice works with single pieces painfully slowly; and grandmasters can work with heavy patterns quickly. \* Direct instruction works with light elements quickly, making sure each move is simple and explicit, and then shifting from step to step at a rapid pace. \* Progressive pedagogies tend to take a problem and allow students the time to grapple with it, tending to gravitate towards the slow and heavy region of the field. The imaginative move I would like you to make is join progressive pedagogy to direct instruction with a downward sloping line and to see them as equivalent.\* In physics we would not have a problem with this. A light object moving quickly has a similar momentum to a heavy object moving slowly. Is it possible to say something analogous about pedagogy, that there is a similar load of pedagogic work going into teaching and learning with a heavy object slowly as with light objects quickly? Intuitively this makes sense. Allow me an illustrative example. In the Czech republic, students do science in a teacher driven manner where questions are continuously fired at the whole class and responses worked with. Its not direct instruction but has similarities. In Japan, the teacher sets a problem and the class spend the period in groups working out how to solve it. Both Japan and the Czech Republic have done really well in the TIMSS tests, the one through student problem solving the other through teacher driven question and answer. There is something similar that’s holding here – both sets of students are getting through the required amount of work but in very different ways. Intuitive support also comes from cognitive psychology. Working memory can hold around seven simple bits in mind, but as soon as the complexity of the task increases this goes down, eventually to one element. Your mind can work quickly with simple elements, slowly with more complex ones. The wager is that you can take a complex task and break it down into simple elements; and you can take a set of simple elements and turn it into a complex task and the simple diagonal line catches the equivalence of this possibility. (26)

Its an inverse relationship that is captured between speed and weight. If you have the same energy, the heavier your load the slower you go; the lighter your load the faster you go. As you run down the diagonal, the cognitive demand remains constant, what changes are the ratios between speed and weight. The device shifts from binary to ratio. The mistake is to think that doing a lot of simple elements quickly adds up to less than one complex element slowly. Both can exist on the same demand curve. For a novice student the demand curve shifts downwards with only small increases in speed or weight possible. For an expert, the demand curve shifts upwards, with an ability to either do far heavier tasks at the same speed \* as the novice or intermediate; or do a similar weighted task far more quickly. \* If we follow the trajectory from novice to intermediate to expert then a more direct relationship between weight and speed emerges. As your cognitive carrying capacity increases so does your ability to work more quickly with heavier elements. The more you can carry the faster and heavier you can go. Place the inverse and direct relationships over each other and a process that is simple but dynamic shows itself. \* To get a feel for this, imagine the pedagogic technique you are working with shows a tendency towards speed, then your cognitive supply curve will shift downwards to the right but as it works its magic and expands your cognitive supply, your ability to work with more difficult topics at speed will increase. You will move upwards to higher demand curves. Just so with a pedagogic technique that shows a tendency towards heaviness, your ability to work faster with heavier topics will increase as you master the topic at hand and you will move on to higher demand curves. Note that all three arrows intersect with the red, blue and green demand curves at equivalent points. \* Lets take the intermediate demand curve. The top arrow intersects with the demand curve at a heavier and slower point than the bottom arrow, which is faster and lighter, but they are both on the same demand curve thus requiring similar amounts of work. 30)

This gives us a simple working model to play with in terms of developments in South African Education. We can historically locate the majority experience of pedagogy in South Africa at the chorus model level. A functional chorus model works with light, repetitive items fairly quickly. The initial reform process after Apartheid aimed at a progressive pedagogy that was on a higher demand curve, but also shifted from repetitive light chants into slower and heavier problem based activities. We knew then, and we know now, that this was a difficult move. Those that took learner and outcome education seriously within poorer schools could at best only stay on the same demand curve and do slightly more complex problems less quickly.\* More recent reforms have shifted away from OBE into a more tightly sequenced and paced curriculum that points in a direction similar to direct instruction. Those that never shifted from the chorus model can use the basis of their familiar practices to shift upwards to a higher demand curve and those who shifted to OBE now find themselves having to reorient towards more specified sequences with tighter time restrictions. The experience of the minority of South African teachers and learners who were on a higher demand curve somewhere between the extremes of direct instruction and progressive pedagogies has been an easier one. The shift to the imagined OBE was possible and sometimes achieved; and the shift to more direct selection, sequencing and pacing models is just as feasible, although mostly, because these groups have powerful assimilation strategies that take outside peturbations and transform them into processes adapted to their internal functioning, they have been able to carry on much as before.

Using these kinds of models as a device for the pedagogic imagination has enormous dangers of over simplification, because you are purposefully stripping the complexity down and working only with a few variables in highly specific ways. It means you can think through the logical and transformative possibilites of the models themselves. You track what the model makes possible and leave out what it cannot see. The art is to work with models that are capable of using simple rules and variables to productive effect. We have not come close to exploring the fruitfulness of this fifth model and as with the other four devices, books are great vehicles to lay them out, as you have time and space to explore their inner working. I would like to end off this marathon with a demonstration of how to play with the fifth model. We referred continuously to demand curves, and many of you might have been asking yourselves why a straight line is a curve? Well, lets put up the three demand curves we have been working with - novice, intermediate, expert – with curves in them. It turns out that this sort of representation gets at the logic of educational change in more accurate ways. If you are a teacher who has got used to working in a quick mode with light elements, then your initial attempts to change towards a heavier and slower model is not going to be a smooth linear affair. \* Initially you might lose a lot of pace, but gain hardly any weight as you struggle with the new pedagogy. You are going to give up a lot of speed for a little weight. As you master the new pedagogy you will increasingly be able to work with heavier elements at little cost in terms of speed. This simple shift from a linear ratio to more dynamic curves holds within it a host of analytic possibilities. In terms of the shift from a chorus model to realised OBE, it points to the tragic reality that there was not a linear shift that exchanged pace for weight, rather there was a massive loss of pace with hardly any increase in weight. To see how bad this was, we can use our earlier discussion of cognitive load theory. Remember that a distinction was made between the intrinsic load of a task; the extraneous load that comes from the intructional choices made; and germane load that comes from getting students to make meaning of the task and network it into long term memory. Notice that germane load has a tendency to slow down the pedagogic process in order to make meaning. Get the germane load right and you shift the demand curve both upwards and towards the left – upwards because you are enabling increasing ability to deal with more difficult deamnds; and to the left because you are slowing the process down in order to make meaning and sense. To get this right you have to make sure that the extraneous load generated by instructional choices is both judiciously chosen and effectively carried out. Get it wrong and the extraneous load swallows up most of the load carrying potential with wasted work that takes away from both the intrinsic load and germane load, causing the whole reform process to flatline.

Never forget that these devices of the pedagogic imagination are crafty schemes. They are tricks. We have not been engaged in pedagogic analysis. We have not modelled or theorised why we chose the variables and states we did; nor what the actual levels are and how they intersect; nor the full range of actants involved in transformative work; nor what the actual regulative principles of education are and how they interact in a power crazy world. We did not use the devices to analyse, explain, or critique - we used them to dance into a world where combinations proliferated, heights and depths gaped, metamorphoses irrupted, and where one single idea of the good exploded into the sky.

Note that at equilibrium there are students who are doing it more easily and students who are struggling… and we have to think of them…