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**Using Energy Dynamics to Explore the Process of Making Sense and the
Role of Multiple Selves in the Teaching and Learning of Mathematics**

Abstract

This is an enquiry into what is beneath energy dynamics (in a psychological sense) experienced in teaching and learning and how these dynamics can be manipulated. It draws on ideas from disparate fields such as psychology, art and literature, to develop an integrated explanatory framework. This is then probed and refined in a mathematics education context.

This thesis explores being in, and manipulating an emotional state and its associated energy. It enquires into how the aesthetic nature of emotions interrelates with intensity of emotions experienced as felt arousal. Based on the conjecture that being in a state is the result of having made sense of some input that triggers one into that state, the question 'how did I get into that state' is asked. It explores what happens in the process of making sense and the virtual places where grouped and accumulated past experiences are stored as Multiple Selves. In this process the roles and existence of assumptions, expectations, disturbances, foci of attention, being in an inappropriate Self or being in a 'fitting' Self, and experiencing flow is explored. Significant

consequences for teaching and learning are investigated, including the notion of developing mathematical thinking.

Juxtaposing and transposing all these ideas offers a complex metaphorical model, a multi-layered, multi-faceted framework that can be used in the analysis of teaching and learning in general. It also offers a structure and direction for developing and analysing task design in particular. It presents a tool to manipulate emotional and cognitive states, to recognize and possibly understand strange behaviour within students and oneself.

This thesis uses phenomenological philosophical methods and a pragmatic way of working within the Discipline of Noticing. What is offered is an articulation of the integrated sense I have made, in the expectation of affording possibilities for readers to notice energy dynamics within themselves and offering a framework for doing so.

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Chapter I Beginnings

Awakening the enquiry

Before teaching mathematics, I taught Dutch literature for some years on the International Baccalaureate programme at a school in Oxford. When reading literary texts I noticed a change in my own levels of energy. For example an elegy, which in most cases mourns the death of a loved one, would carry me into a slow mood and low energy phase; a comedy such as the Comedy of Errors by Shakespeare, could have me shouting out with laughter and I would feel full of energy after that; a tragedy such as King Oedipus by Sophocles, could, on the one hand, leave me devoid of any energy and, on the other hand, energise me to make me think about the tragic connections in the play.

I also noticed while analysing characters in plays how authors use multiple selves to build characters and how tensions can be created and cultured because of the mixing-up of these multiple selves. For example in King Oedipus, which typifies a classical Greek tragedy, Oedipus is the hero and

protagonist of the play and symbolic example of a human being (Van Gorp *et al*, 1986, p420). He mixes-up – unaware and because of a tragic mistake – his son-role with his husband/lover-role: he kills his father and marries his mother. The confusion of these Selves destroys the natural order of human relations and leads to a fatal disturbance, resulting in the tragic end of the play, a process of heroic suffering.

During my first year of teaching mathematics this awareness of energies was re-awakened by my mentor. He believed that teaching was about energy exchange: when teaching you should think about energy levels of your students and energy levels of yourself, the teacher, and then act in a compatible way.

I started acting on this awareness, experimenting to influence energy levels and types of energy within myself and with my students. I asked myself: what are these energies, can I define them? How do they get triggered, how do they get to be there? Is it relevant to my teaching? Can these energies be manipulated, because that would be useful in my classroom? Can I find out what is beneath these energies?

Hence, a thesis.

What I will attend to in this thesis

In this thesis I will attend to and research in detail notions of energies in a psychological sense, and the experiencing of energy flows and fluctuations. An input, which can be a smell, a written sentence, a heard expression, triggers me into a flow of energy of which, in that moment, I have no idea of its outcome. I imagine this flow of energy as *River of Energy*. I use this mental image because descriptors of a river flow and of energy seem to have similarities such as ebbs and flows, deep pools and thundering waterfalls, rapids and meanders, gentle trickles, nearly static slow moving water and raging torrents.

I will use this image of *River of Energy* in two ways: I will be a passenger on a journey on the river of energy, following its course wherever it takes me. At the same time, I will also explore the places this journey takes me to – why do I flow from this place to that, what happens in a certain place, why does this happen, why does the river change shape, what are the characteristics, what are the elements, and can I influence the course it takes? Through this process I have increased my awareness and identification of energies within me and awareness of differences in intensities. Hence, I will study the phenomena not only in terms of essentials, but also in terms of relations.

By exploring the *River of Energy* and finding out about the flow of energy I

have used these findings to inform my lesson planning, to gain insight into manipulating these energies and to influence my teaching and learning of mathematics.

Descriptive incidents have come from my own mathematics classroom, from lesson observations of other teachers in my role as research officer for the Improving Attainment in Mathematics Project (IAMP) at the University of Oxford and from happenings and incidents in my everyday life. I taught for 7 years and used my own classroom for data collection for 4 years from 1999 to 2002 with observations recorded in a research journal; I observed and interviewed teachers as a research officer for 3 years from 2002 to 2004. Data collected in this project and used in this thesis consisted of audio-taped lessons and conversations, video-taped lessons, and observations recorded in a research journal. Permission to use data from the IAMP project has been sought and obtained.

Is this thesis relevant?

What I will say in this thesis is not always new and often seems like common sense on first reading. However, common sense often emerges only after someone has articulated it. Once articulated it can be challenged, developed and used. I draw upon ideas from disparate fields such as psychology,

literature and art which I then integrate into an explanatory framework. This I then probe and refine in a mathematics education context.

I neither intend nor pretend to offer the one and only interpretation and exploration of energies. On the contrary, I believe many interpretations of energy flow are possible. What I hope to achieve though is that this thesis will offer the reader some new insights into life generally, and into teaching and learning mathematics particularly, as it did for me. Awareness of energies can make it easier to make sense of what students are feeling and doing, as well as informing you of alternative strategies and behaviours as a teacher; multiple selves help account for both student behaviour and your own different behaviours in different situations. I take heed from a quote of Alain de Botton (Proust, 2003):

“The work of an author is nothing else than some kind of optical instrument that he offers the reader to let him notice what he, without the book, maybe would not have seen”

(Quoted in Proust, 2003, p13)

Structure of the thesis

The nature of this enquiry, the method and background methodology, is addressed in Chapter 2, together with an explanation of how literature is being

incorporated and reviewed. Then follows the core exploration of the thesis.

Starting with the notion of energies, I have been making observations and trying to develop a language to articulate in detail the ebb and flows of energy, and their relevance to the classroom. I investigated how they could be used to account for what I observed in the classroom and how I probed beneath these energies – what is cause and what is effect.

Chapter 3 describes this study. In the process I developed an image in the form of a diagram which I used to depict the experiencing of emotions as a first attempt to describe changes in energy intensities, to explain fluctuations and to explain the dynamics of energy.

One of the conclusions of Chapter 3 is that the location of *where* the energy transformations are determined and made actually happens during the process of making sense. Chapter 4 looks at what happens in that process of making sense, using ideas from a wide selection of authors in psychology, enriched with theories from the worlds of literature and visual art. Of great influence is the ‘Reception of Aesthetic’ or ‘Reader-Response’ theory from literary analysis. This, combined with examples from my classroom and my ordinary life, lead me into discussing and investigating notions of perceptualising, conceptualising, assumptions & expectations, disturbances, their manipulation

and application to the classroom.

The big question at the end of Chapter 4 is where these past experiences are stored that are triggered in the process of making sense and this leads me to Chapter 5, where I probe the concept of Multiple Selves as virtual places where these past experiences are located. I look at elements and characteristics of the Selves and explore the entailing energy dynamics and consequences. Throughout the Chapter I use these findings as a way to account for surprising behaviour in the classroom.

Chapter 6 offers an overview of energy dynamics, which I have encountered on my journey on the River of Energy. The crux as a classroom practitioner is not only being able to identify these different energies, but being able to manipulate these within myself as a teacher and with my student-learners. Ways to do this are described in this last chapter, which also gives a summary of the rest of the thesis and critical self-contemplations that have occurred to me.

Tone of the thesis

My thesis tells about the development of ideas in a rigorously methodological and hopefully convincing way. Like many students I have found the writing-

up of this thesis at best times hard, at worst times impossible and utterly frustrating. This was partly because, in common with other students, I had to develop my own vocabulary in order to articulate what I was thinking. But also, because my thesis is about energies and energy dynamics, the energetic states of my readers concerned me. I wanted to write something that the reader would enjoy reading, using a style that captures and bolsters their energy and guides them into a flow.

The importance I attach to this can be illustrated by this quote about Gabriel Garcia Marquez:

“Beginnings matter. They always have. Middles have no limits – they can scrunch up or they can sprawl. Endings may be left open, ambiguous, incomplete. But no novel has ever not begun. And if it doesn’t begin right, the suspicion is that the rest won’t be right either. Gabriel Garcia Marquez has said that he sometimes spends months on a first paragraph, since it’s there that the theme, style and tone of a book are defined – solve that and the rest comes easily’

(quoted in Morrison, 1999)

In this thesis I am using descriptions of incidents from the classroom and also

from my ordinary life. They have been selected from my journal kept during 1999-2002 because I think they are easily recognisable. They are offered as a particular exemplification of the general and should offer an illustration of the *phenomena*. Throughout my thesis, names have been changed to avoid identification of sources where reports are given of classrooms; other names in examples from my ordinary life are used with permission.

I hope you enjoy reading it.

Chapter II Nature of the enquiry

This thesis is a methodical work. The underlying research involved systematized observation, experiment, and induction.

Phenomenology

The methods used in this enquiry have elements and characteristics in common with phenomenological methods.

Phenomenology is a philosophical movement, which emerged at the end of the 19th century from a group of German philosophers. The most well known classical phenomenologists are Husserl (1859-1938) and Heidegger (1889-1976). Husserl is considered the ‘father’ of the movement, and Heidegger was one of his students at the University of Freiburg. Both have a background in mathematics and an interest in the philosophical nature of mathematics.

Phenomenological study concerns different forms of experience just *as we*

experience them, from the perspective of the subject living through or performing them. Heidegger described it as ‘the study of structures of consciousness as experienced from the first-person point of view’. The expressions *phenomenon* and *phenomenology* originate from the Greek language and mean respectively ‘that which shows itself in itself’ and ‘to let that which shows itself be seen from itself in the very way in which it shows itself to itself’ (Heidegger, 1967, p51 and p58). Experiences of seeing, hearing, imagining, thinking, wishing, desiring, willing, acting and of emotions can thus be characterized.

Common elements and characteristics

Phenomenological reduction

The first element my enquiry has in common with phenomenology concerns the approach to enquire and what Husserl calls ‘*phenomenological reduction*’ which aims to locate the ‘pure data’ of a phenomenological enquiry. It involves suspending all judgemental beliefs characteristic of the ‘natural attitude’ that is, the attitude of common sense and science. To do that, reflection has to be on the content of the mind to the exclusion of everything else. (Husserl, 1964, pp xvi, xvii, 34, 35). What I did was I looked at my everyday personal life and my experiences as a teacher of mathematics. I

explored and analysed these from a point of view of virtual energy flows and fluctuations hidden within myself while looking and probing for phenomena and what underlies these phenomena. The exploration required me to become conscious of my consciousness and to think carefully about what goes on in my mind, looking for its structures and the phenomena that identify these structures. Thus my approach to enquiry involved regularly inspecting my own experiences before trying to connect with the experience of others. Furthermore, in the next chapters, I go so far as to offer you, the reader, some tasks because it is only through recognising what I am saying in your own experience that you can approach the issue of validity. In addition, I expect that when you read extracts from my observation journal, or indeed extracts from other authors' writing, you will be seeking connections with your own experience.

Indefinability of the notion of energy

The second similarity comes from the vagueness and indefinability of the notion of energy. The expression *energy* is readily used in everyday language and descriptions of life experiences. However, when trying to describe or define *energy* beyond 'that which gives me the force to' (my definition) I found myself running into trouble.

Heidegger had a similar problem with his notion of Being. In his book 'Being and Time' Heidegger (1967) questioned and contemplated whether it was

relevant and necessary to investigate its meaning. It had been maintained that exploring of Being was irrelevant because the concept of Being is indefinable, as Being can not be conceived as an entity, nor that it can acquire such a character as to have the term entity applied to it. But Heidegger argued that does not mean that the concept of Being no longer offers a problem. He argues that the indefinability of Being does not eliminate the question of its meaning and that it demands that we look the question in the face (Heidegger, 1967, pp22, 23). Similarly, although after all these years of researching the phenomenon *energy* I still find it difficult, if not impossible, to define the notion of energy, it does not imply that the notion has no meaning. On the contrary, as we use it often in everyday language, the word energy refers to some experience even if it is not a 'thing'.

Heidegger discusses this vagueness, this difficult-to-grasp aspect further in his description of what can be considered a phenomenon:

“What is it that must be called a ‘phenomenon’ in a distinctive sense? Manifestly, it is something that proximally and for the most part does not show itself at all: it is something that lies hidden, in contrast to that which proximally and for the most part does show itself; but at the same time it is something that belongs to what thus shows itself, and it belongs to it so essentially as to constitute

its meaning and its ground”.

(Heidegger, 1967, p59)

Analogously, energy can be considered a phenomenon because it is hidden. It does not show itself as it is, yet, it belongs and underlies manifestations in human behaviour such as joy, shouting out, feeling depressed, which are manifestations of energy dynamics. Energy’s indefinability and hiddenness are an essential part of the characteristics of a phenomenon of the type studied by phenomenology.

Virtuality of the notion of energy

Another aspect of phenomenology that struck me and that I found most insightful is how ontology is approached. I struggled like Husserl with the ‘virtuality’ or the existence of the subject of my enquiry: the notion of energies and energy dynamics in a psychological sense. I have no physical proof that ‘energies’ exist nor can I physically measure it or pinpoint where in the body the energy is at a certain moment in time. It is a kind of ‘virtual concept’. I will be introducing more ‘virtual concepts’, for example the notion of Multiple Selves later. Husserl addressed the matter of researching virtual concepts by arguing that

“Every intellectual process and indeed every mental process

whatever, while being enacted, can be made the object of a pure 'seeing' and understanding, and is something absolutely given in this 'seeing'”

(Husserl, 1964, p24).

Phenomenological reflection does not presuppose that anything exists, but sets aside the question of the real existence of the contemplated object, because the mind can be directed toward nonexistent as well as real objects. Hence the existence as such of energy in a psychological sense is not a prerequisite for 'seeing' it as phenomenon. This greatly re-assured me, as this is a doctoral thesis.

Intentionality of the object

I am a pragmatic person and this at times causes conflict in me when I question the *meaning* of some research. This important issue of meaning is also present in phenomenology where an experience having meaning, or content, is seen as the central structure of experience. It comes, in essence from the content or meaning that I give to the object of the experience as it is the object I am focussing on that directs the experience. This direction, or *intentionality* as it is referred to in phenomenology, gives the experience structure (Husserl, 1964, pp43, 44).

Similarly in my enquiry, the structure of this thesis comes from the meaning I

have given in the conceptualisation or understanding of the elements of energy dynamics (the objects) I encountered on my journey. Any of the phenomena explored in this thesis have meaning individually and as part of the whole picture of energy dynamics.

As this thesis subscribes to the philosophical school of phenomenology, it implies it has a strong philosophical dimension, as things might at times look very theoretical and abstract. However, my philosophical theorising has come from practical settings of the classroom and in my ordinary life. The resulting theories have, in turn, been developed so that they are of practical use to me in similar or related settings.

At times, this thesis includes descriptions of the thinking process I went through. This is included for several reasons: the process for me is at least as important as the findings; it helps to build up a picture gently and comprehensively; it illuminates my flow of energies; and it demonstrates my process of making sense, which is very important in this thesis.

Hence, I could argue this is a phenomenological philosophical thesis with a pragmatic aspect. But within myself, I think I did something more.

Discipline of Noticing

My initial plans for this thesis were to use two kinds of information. The first being my own awareness, experiences and thus inherently personal interpretation of issues relating to energy. Because this would so clearly come from within myself I considered this useful, but subjective. More objective data would come from observations by me of my students. However, early in my research I realised things were not so clear-cut. I wrote in my journal at the time:

“I had wanted to focus on practising writing about observations such as why I thought the students were excited, disturbed, etc. This ‘objective’ observing proved rather difficult, because I think I make too many assumptions about what the students’ feelings are, and I discovered I was not really honest about my observations by having the tendency to notice what I want to notice. Very disturbing for myself. I also make assumptions about what the students’ body language means. No, no, it has to be a lot more ‘exact’ for me to be convincing. I want to read more about this before I feel confident to do this again”

I realised that in the process of ‘observing’, I was, in a sense, inferring the data without being able to define how this inferring was taking place. What

was 'objective', what was 'truth'? I struggled with these notions of objectivity and truth for a long time.

Slowly, I started to accept that what I tell in my stories and examples is OK, and not so different from 'objective' data. The particular incidents I use in this thesis come from my personal experience. They may speak to other people, indeed I truly hope so. But perhaps the most important issue is the way of working: to be alert to situations, to recognise similarities and analogies and to ask myself "Is there an analogy with this situation in the classroom or in my ordinary life?"

As Gattegno says:

"Why is it that we prefer to look from the outside at everything which is actually part of our inner life and hence, taken by our own preference, we miss so much which could be of help? Why is it that we do not understand that we can reach objectivity by ourselves in so many instances and thus gain validity beyond our person? Why is it that we accept instead, that only subjectivity is our lot while believing that subjectivity is weaker than objectivity?"

(Gattegno, 1985, p8)

Natalie Sinclair describes a similar experience

'Since it is difficult to monitor the thoughts and feelings of others as they engage in mathematical activity, I examine my own experience in order to develop a set of criteria'

(Sinclair, 2002, p47)

Hence, what I am offering in this thesis is not THE truth. What I am offering is my articulation of the sense I have made.

The nature and process of my inquiry is beautifully described by Mason (2002) in 'The Discipline of Noticing':

"For me, the answer to how we come to 'know' or perceive something new lies in a development of sensitivity.

Undifferentiated experience provides the ground or substance which serves as a component of an action involving subsequent experience, which acts as the core for further discrimination, and hence a sensitivity to notice. At first I do not see. I do not make distinctions. Then, through the construction of my brain and supported by social practices (particularly language), subsequent

sensations sufficiently similar to past experiences are linked or connected together. My brain accumulates apparently similar sensations (using all senses and corresponding associations and thoughts), organises these into networks of connections and through labelling, provides metonymic access in addition to the metaphoric access of resonance. These bodily-mental-affective processes then inform action and activity”

(Mason, 2002, p232)

Validation

Validation of my conjectures, ideas and interpretations comes through three different levels:

Firstly, the way I have been working on my sense making. Literature on energies proved at best fragmented and starting my enquiry with a literature review proved unfruitful. Hence, the way of working I developed consisted of first developing my own language, my own conjectures and attempts to identify the phenomena. Only after having identified the phenomena within myself could I look for literature that would support, demolish, expand or refine such ideas.

Using literature in such a way leads to a second level of validation: with this

way of working I was using literature to check whether it resonated with my ideas and conjectures, and thus probing my own thinking.

A third level of validation comes from the reader, through the identification and recognition of the examples with their own experiences. This is personal and will differ from person to person. It is not meant as an opt-out clause for me as it implies that the onus is on the reader to test against their experiences. The examples have been chosen with delicate care to illustrate the phenomena I have identified and then presented in such way as to facilitate identification and recognition and, hopefully, awaken sensitivities, awarenesses and consciousness of the conscious, i.e. make you, the reader, notice freshly.

Exemplification and reviewed literature

As mentioned in Chapter 1, I offer descriptions and incidents from my classroom and from my ordinary life as exemplification of identified phenomena. These examples also have another role to play: they have been developed and inserted with the aim of not only offering a metonymical experience of going with the flow of the writing of this thesis, but also incorporating a metaphorical experience that would allow you, the reader, to be drawn into the structural and accumulated aspects of the arguments of this thesis. The further exploration of metaphor and metonymy in this thesis will, I hope, make this intention and effectuation clearer.

Many varied concepts from different 'worlds' will be explored and connected in this thesis. It is therefore not possible to do a literature review *prior* to the moment these concepts arise. Hence relevant literature of the concepts will be reviewed as and when appropriate.

Chapter III Developing sensitivity to the notion of energies

In the first chapter I talked about how this enquiry into energy dynamics came to be awakened. I described how at first I noticed a change in my levels of energy when reading literary texts depending on its genre; how I also became aware that tensions can be created and cultured by playing with the mixing of different Selves; how, when I started teaching mathematics, this notion of energies was re-awakened by my mentor who believed that teaching was about energy exchange between the teacher and the students; and how I started acting on this awareness by experimenting in order to influence energy levels and types of energy within myself and with my students. I talked about questions that arose such as what are these energies, can I define them? How do they get triggered, how do they get to be there? Is it relevant to my teaching? Can these energies be manipulated, because that would be useful in my classroom? Can I find out what is beneath these energies?

In Chapter 2, I attended to the nature of this enquiry, probing issues such as looking for the phenomena, working with virtual concepts, and exploring the

principles of phenomenology and ways of working with the Discipline of Noticing. To further my journey into energy dynamics I first had to educate myself to becoming aware and sensitive to the phenomena hidden within me. What follows describes how this happened.

Educating to becoming aware

Whilst completing my teacher training, I was introduced to the Science of Education Reading Group who read and explore writings of Caleb Gattegno, educationalist, linguist and mathematician. His writing has been, and still is, a great source of inspiration for me and has been very influential in my way of thinking and in the development of this thesis. Gattegno placed *awareness* and *forcing awareness*, by which he means ‘that which is obvious and hence may escape us, has to be made striking’ (Gattegno, 1985, p9), as the essential element in education and claimed “only awareness is educable” (Gattegno, 1987b, p220). His psychological and at the same time philosophical approach to awareness allowed me to become aware of my awareness, manipulating this state within me, experiencing flows of energy and identifying underlying phenomena.

In his book ‘The Mind teaches the Brain’ (1988), Gattegno writes

“sensitivity [...] can be aware of itself, sensitive to itself [...] it is educable [...] We can make ourselves vulnerable to humour, beauty of someone’s teeth, to the presence of others. We can educate our brain to pick up smells...”

(Gattegno, 1988, p220).

To develop my sensitivity to such issues of ebb and flow of energies I now had to educate myself to becoming sensitive and to being aware of that sensitivity, to being sensitive to the sensitivity itself. For achieving such state of sensitivity I had to prime myself and my brain to be vulnerable to energy dynamics so that it would be able to pick up the information needed to identify the phenomena on my journey on the River of Energy.

One of the first hindrances in this process was the lack of a language or idiom to talk in. In my communications I found that this lack of vocabulary led to my listeners not hearing what I wanted to say. Linguist and morphologist Roman Jakobson argues that the *langue* of a text is actualized as *parole* by the receiver (the reader). This *parole* is never the same as the *langue* and the shift happens in the process of receiving (Jakobson, 1985, pp147, 148, 159). What happens in that process is dependent on the personal experiences of the reader and not therefore within my control. However, the *parole* of my listeners was very different to what I thought I had said in my *langue*. The first step I had

to take was to develop my *langue*, to make it clearer, more precise and thus less prone to becoming a **totally** different *parole*.

I needed clear definitions for the concepts I talked about. I started to collect and write down incidents in my classroom where I had experienced the presence of different kinds of energy. A ‘dictionary’ developed. As a hook, I first focused on descriptors John Mason uses such as ‘starting’, ‘sustaining’ and ‘finishing’ energy (Mason, private communication). I wrote in my journal at the time:

“I find myself thinking a lot about different types of energy, i.e. starting energy, sustaining energy, finishing energy. I’ve been playing with this in my classroom, trying to break this traditional pattern of a lesson: starting energy followed by sustaining energy followed by finishing energy. I managed to do this to a certain extent. For example to create or increase the starting energy, I looked at the effect of brainstorming and of creating suspense by using tantalizing titles.”

A description of these lessons

The lesson of tantalizing titles and creating the will to engage – an account from my journal

"A dreaded start to the lesson. Year 11, the weakest group. They are difficult to inspire. At least for mathematics. They have been in class for about 5 minutes. Some came late. Two girls are ready, books on desk, facing me and the board, waiting for me to start the lesson. I have spurred the others on already, "come on, hurry up", "you are so slow to-day", "books, Sian", "are you ready, Mona ?". To no avail. What to do? Cajoling them along will not make a successful lesson today. I can feel it. And see it. Sian now has her head on her arms, facing away. Anna is sitting at a 45 degree angle from her desk, turned towards her friend, wanting to talk, and I do not expect it is about maths. Mona is trying to distract me, with her wonderful smile, asking me how my weekend had been. No, these girls are not showing a great will to engage, rather showing a will not to engage. And imposing discipline will cause resentment, I fear, because I think they want to provoke and rebel today.

I turn to the board, and start writing. I hope this will give the girls an indication that something is going to happen here. But what am I going to write ? How can I win them over? I realise the start of the lesson is going to be crucial. I'll have to capture their attention, their imagination. Create suspense. And afterwards, I

think we need a soothing exercise, something calm and rhythmic, something they can do. Maybe repetitive exercises, and suggesting they check their answers regularly, so they get a boost from ticking their answers. Not too many challenges today. Rather different from what I had planned. Here we go.

I write a title: "The game of standard form". And wait. With my back to the class, I spend some time writing the date on the board, underlining the title. I can hear them whisper "The game of standard form". "We are going to play a game". "What, what,...". I turn around. I can not believe my eyes. They are all facing me, sitting upright, even Sian. They are ready. They have got the will to engage. The tantalizing title provoked in the students the energy to create the will to engage."

What happened here is that by changing my plans in the moment in response to the students' frame of mind I managed to create suspense and evoke and release starting energy and a will to engage with the lesson. It showed me that I could manipulate the energy flow of my students. And that gave me great hope for my teaching.

The lesson of brainstorming: creating the desire to engage— an account from my journal

The background: year 7, mixed ability. Linda, a student teacher is teaching this class for 6 weeks. I sit in the back of the classroom observing the lessons. The account involves two consecutive lessons.

Lesson 1: It is the start of the lesson. The girls are sitting quietly, books and pens on the table. They are all facing the board, sitting straight. Their faces are stern, showing concentration. They are willing to listen to what Linda has to say. They are ready, they are expecting action from the teacher. They have the will to engage. Can this will be turned into desire, into an intensive and overwhelming willing?

Linda starts talking about the marked homework, to discuss the problems some had. Several girls had experienced no problems.

One of them is Rina. Her straight back becomes rounded. She leans back in her chair. After a while she starts looking around.

Other girls are doing the same. Some are moving their feet, some are twiddling with their hair or muttering things to one another.

The first chance of creating desire is lost.

I discuss this with Linda after the lesson and she decides to start the next

lesson with another activity.

Lesson 2: The girls, again, are sitting quietly, facing the board, sitting at a right angle to their desks. Their faces show concentration. They are willing to engage. Linda starts talking. About triangles. What do they know about them? A brain-storm follows. Immediately, 75% of all hands go up. Most have stretched arms, some are bent. One girl has two arms up at the same time! They desperately want to share their knowledge and ideas. Backs are straight. There is an overwhelming sense of participation in the class. A buzzing feeling. A sense of overflowing energy, which spills over to the rest of the class. Girls who initially were not taking part, now want to join in as well. Desire is created. They want to do this. Now, immediately. The girls pick up suggestions from others and expand on them. Group energy, as I call it, is released, i.e. a sense of really working together, everybody, students and teacher. Both Linda and I start smiling automatically. This is such a good feeling. It gives even me, the observer, such a buzz, a wagon load of energy to carry on, to do it again, to want to teach, to join in, causing the desire in me to engage. The students had returned the energy that Linda had initially directed to them (defined: reciprocal energy).

It was such an inspiring experience. Beautiful. Wonderful.”

The contrast between the start of the two lessons illuminates the difference between a start that has a sense of ignition and channelling of energy and one that seems to evaporate and diffuse the starting energy.

The two examples, ‘Brainstorming’ and ‘Tantalising Titles’ are similar in a sense that they both evoke a starting energy and a will to engage. They are different in that in the ‘Brainstorming’ lesson this starting energy is being released by participation and offering opinions and answers, while in ‘Tantalising Titles’ it is manifested in being attentive to what might come.

I am tempted to describe the participation of the girls in the second lesson of ‘Brainstorming’ as a display of signs of ‘ownership’. What I observed is students picking up ideas and re-iterating them. Hence I could describe it as ‘owning’ in the sense that what they re-iterate is ‘theirs’ as they have been involved personally in its discovery and it is an articulation of part of their personal ideas.

Through exploring such examples in my classroom I began to identify and define different kinds of energy that welled up in me, that I noticed in myself and in others and I looked at what happened within these states. I was

developing an idiom to describe the effects of certain actions and to capture the sometimes-subtle differences between the energies. At the same time, I noticed that the energies as defined by me, could be changed, manipulated and, to a certain extent, controlled. I continued experimenting in my classroom looking for ways in which I could manipulate and control the energies of my students and myself by working on small changes in the pedagogy of my teaching.

In a rather eclectic way, sometimes planned, often ad hoc and over a period of half a term I made changes in:

- Planning: depending on time of day/ near break time, weather, day
- Rhythm: slow, staccato, varied pattern, erratic pattern
- Loudness of my voice: loud, silence, whispering, talking
- Permitted noise level in class: silence, quietly talking in pairs, whispering, talking in groups, no restriction on noise level
- Class discussions: answers with hands up, shouting out
- Questioning: instant response, waiting
- Body movement: waiting, slow movements, pacing, changing my position in the classroom
- Body language: relaxed hands by side, 'thinking', gesticulating, excited
- Facial expression: stern, relaxed, non judgmental, anticipating, smiling
- Communication with students: individual face to face, individual in

class, plenary

- Positioning when communicating with students: standing, sitting (they, me, both)
- Use of resources: board, their exercise book, my exercise book, piece of paper, body, hands, sound
- Sequencing of topics: linked by concepts, linked by imagery (e.g. ratio and enlargement)

As stated earlier, these changes were not varied in a systematic way against each other or against themselves. They did not offer me clearly quantifiable data. What they did offer me were dimensions of sensitivity in what I tried to notice.

The responses to these changes by my students and myself did indeed often lead to a change in energy. The response was often what I hoped for. On other occasions though, things did not go as I hoped. Questions arose such as: What is implied in *what I hope for*? How do I quantify these energies? Am I trying to manipulate energy, or am I working on emotions? Is there something similar between emotions and energy?

Emotions and energy – developing a diagram

I could sense a connection between emotions and energy – I noticed that with an emotional response, I could feel a surge in energy, an ebbing away of energy, even a sudden total void of energy.

Although I could identify a connectedness between emotions and energy, I queried the validity and rigour of such phenomenon. I felt uncomfortable with the notion of *emotion* described in the dictionary as ‘strong instinctive feeling such as love or fear’ (Elliott, 1997, p242), with no role for *cognition*. I felt reluctant to be drawn into seeing emotion as a source of energy dynamics directed only by an automated instinctive response. However, I found validation and reassurance for following my enquiry of energies in the realm of emotion in the writing of cognitive psychologist George Mandler who analysed the relationship between cognition and emotion. He argues that emotions are manifested in two concurrent ways and constructed in a state of consciousness. The first way emotion is manifested is *intensity of emotion* and comes from autonomic arousal. The second way concerns the *quality of the emotion* and is determined by evaluative cognition. Hence, Mandler sees emotion as a product of cognitive schemas, arousal and consciousness (Mandler, 1985, p115), not only automatic arousal.

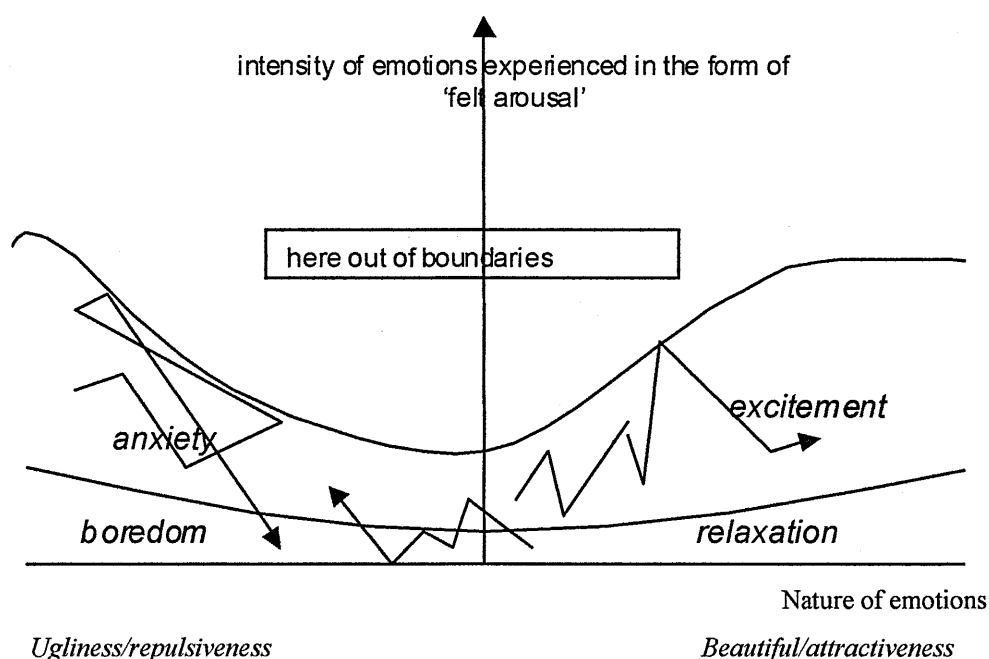
I could now describe my sensed similarities between emotions and energy in

terms of

- their nature - 'beautiful, attractive, pleasant' or 'ugly, repulsive, unpleasant'
- their direction - 'uplifting, growing' or 'depressing, diminishing'
- their magnitude such as 'high, intense' or 'low, dispersed'.

To help me make sense of energies and emotions in terms of quantity, direction and nature I developed a mental image in the form of a diagram, using these distinctions. Any point on that diagram would describe the state of mind I am aware of being in at that moment, in that situation.

What the diagram looks like:



The **horizontal axis** indicates the nature of the felt emotion on a continuous

scale, the *quality of the emotion* resulting from evaluative cognition in Mandler's terms. When I find myself around the origin I experience the nature of the emotion as neutral. When I find myself on the right hand side of the origin, I would label the nature of the emotion as 'beautiful' or 'attractive'. Finding myself on the left hand side of the origin, I would describe the emotion I am experiencing as negative, as 'ugly' or 'repulsive'. The further away from the origin, the stronger these natures become and I would experience these states as very beautiful or very ugly.

The **vertical axis** tells something about the quantity of the emotional response. This is Mandler's *intensity of emotion* determined by the autonomic response. It shows how "emotions are often described as intensities: we get strong emotions or things 'leave me cold'" as Mandler describes this (Mandler, 1989, p8).

But how to measure these intensities? In psychology research these intensities are sometimes quantified by 'measuring' the visceral response of people. Mandler explains this visceral response as a response "activated by some autonomic nervous system activity such as increased heart rate, sweating" (Mandler, 1989, p8). It is tested in laboratory conditions by tracking for example perspiration on the legs, or monitoring the heart rate. However, I had no access to a laboratory and more importantly, I also wished

to include deep-seated non-visceral responses such as a sense of turmoil in my head or butterflies in my belly that I experience when I am in a certain state of mind.

Inspiration came from Michael Apter, American psychologist, with a background in research psychology who developed a motivation theory called 'Reversal Theory'. In this theory he describes 'state of mind' as a 'combination of level of arousal and nature of arousal' which fits with Mandler's descriptors. He argues that in different states of mind

“the arousal feels different in some important sense. The amount of arousal which you feel will be different [and] the arousal experience will be found to differ ... in terms of its pleasantness or unpleasantness.”

(Apter, 1981, page 27)

Apter uses a further categorization based on four everyday widely-used arousal words: Anxiety (unpleasant and high arousal), Excitement (pleasant and high arousal), Boredom (unpleasant and low arousal) and Relaxation (pleasant and low arousal).

'Felt arousal' seems a good descriptor to 'quantify' the intensity of emotions,

including both visceral responses and other deep-seated non-visceral responses. The vertical axis is thus labelled ‘intensity of emotions as experienced by felt arousal’.

Apter’s descriptors of the nature of emotions as ‘pleasant’ or ‘unpleasant’ seemed similar to ‘beautiful/attractive’ and ‘ugly/repulsive’ and have been applied to the diagram. By accepting Apter’s descriptors, his categorization of four states as relaxation, excitement, boredom and anxiety made sense as well. However, as I have named ‘states of mind’ as ‘states’ earlier on, I will call relaxation, excitement, boredom and anxiety ‘sectors’ on the diagram.

In the diagram I look at correlation between the nature of the emotion and the intensity of the emotion experienced as felt arousal. Hence, each point in this diagram describes a state of excitation, at a certain moment, in a certain situation. The state is decided by two factors: the nature of the emotion (pleasant or unpleasant) and the intensity of the emotion, experienced in the form of ‘arousal felt’. Following Apter’s categorization these states can be in the following sectors:

	Low arousal	High arousal
Pleasant	Relaxation	Excitement
Unpleasant	Boredom	Anxiety

When I find something beautiful, I experience this as pleasant. Sometimes I feel highly aroused and excited, at other times I feel utterly relaxed. For example: I find myself surrounded by beautiful nature, silence and lovely smells. I can feel highly aroused and excited. It can literally take my breath away. I find myself getting lyrical about what I notice, starting to sing or recall poetry. At other times, I feel utterly relaxed and pleased, with low arousal. I hum, not sing. On both occasions I would label the occasion as very beautiful and pleasant. Similar experiences take place on the left hand side of the diagram: when I find something ugly, I experience this as unpleasant. At times, this comes with high arousal and anxiety, at other times, I acknowledge the ugliness but I do not feel aroused, I feel bored. For example, when getting mail shots from charities with examples of people's suffering, I can think 'this is indeed awful but I've seen this all before', bin the leaflet and forget about it. Other moments I think 'this is indeed awful. Imagine if it happened to my son' and I get anxious.

Around the origin is a zone of low felt arousal. There is no clear sense of feeling pleasant or unpleasant – the state I am in feels neutral. For example, when I am driving to work, the scenery may be nice, but I do not really notice. I see without being aware, without my mind being present. I am in a routine, in a state of familiarity with low arousal. In the classroom this can be a state I want to get my students in when for example they are unsettled and

volatile in their emotional responses. In such cases it might be energising to have a routine and to be settled. At other times, I do not want my students to be in this state because they would give automated responses without much thinking.

An illustration from Alexandra's classroom: multiplications

Alexandra is one of the teachers who participated in the Improving Attainment in Mathematics Project. I observed her lessons many times. This is one of them:

Alexandra considers her year 8 challenging in behavioural terms. To change this behaviour and to get students to learn in the way she wanted to achieve, the students had been given exactly this same task nearly every lesson since the beginning of term. The task consists of a worksheet with 150 multiplication questions (times tables), given to the student by the teacher the moment they enter the classroom, one by one. The questions are presented in 3 columns of 50 questions each. They have 20 minutes to do this task and time starts running from the moment the first student gets the sheet. They write on the sheet. If finished before the end of the allotted time, another sheet with multiplication of times tables, but presented in table form is given to them. This extension sheet is named and the same sheet is returned to the student every time the

first task is finished early.

The task is done in complete silence. When a student talks, they have to write a 'T' on their worksheet and 10 marks are taken off their total for each T. They can get more than one T on a sheet. If they have five T's on one single sheet, they have to come in after school and stay quiet for 20 minutes.

If they complete all questions (150) and they are all correct, they receive chocolate from the teacher. If they improve on their personal best, a commendation is given. All marks are recorded on a big mark sheet displayed on the wall.

After 20 minutes, sheets are collected by the teacher and LSA and work from the left half of the class is given to the right half of the class and vice versa to mark.

To mark, Alexandra calls out the answers, only the answers, not the question or the question number. This happens at a fast speed and in a rather quiet voice. Even if students can not follow, they have to stay quiet. The teacher calls out the answers for one column, waits for what seems like a long time, then calls out the answers for the next column. During the pause, students can ask for specific answers to be repeated. In the lesson I observed, 1 student asked for this. During the pause, students have to record the total marks for that column at the bottom of the page and at the

end, add the results.

When all this is finished, students leave the sheets on their desk and move onto the next task set, which is projected onto the board from an OHP. The teacher collects the sheets and records the results on the wall chart, if possible in the same lesson.

I asked Alexandra about her purpose and rationale of this task. She considers this class very difficult behaviour-wise and she had found that the students would behave as long as they are not asked to think, such as when working from a text book. But Alexandra wants her students to think and this set-up is part of teaching the students how to behave when doing, for them, challenging tasks, which include concentrating, working independently, listening, impartial marking, listening to instructions, being late having consequences. Alexandra had chosen multiplication as mathematical activity, because she considered addition too easy; subtraction and division too tricky.

Previously students would take up to 20 minutes to arrive in the lesson, in all kind of states. By choosing this task, Alexandra manipulates these states of her students to a neutral and low arousal mode. By giving rewards for personal improvements and by building in a sense of suspense through setting a time limit she hopes to move her students to a state of light arousal, which could be in the boredom sector, but preferably in the pleasant sector. Then,

they are ready to do the next task. I will come back to this example later to explore it further.

Moving towards another point – oscillations

When I am in a state of for example finding something beautiful, I experience fluctuating positive and negative thoughts although I do stay in the pleasant zone. For example I noticed flowers in the house of friends. I thought ‘Nice flowers’ followed by ‘Would I want them in my house? No, they would not fit in my rooms’. Within a fraction of time I had positive and negative thoughts while still staying in the pleasant zone.

I experience these movements as changing directions. When in the pleasant zone of the diagram, I feel more aroused with positive thoughts and my arousal is reduced with negative thoughts. The positive thoughts can take me to a state where I feel excited. The negative thoughts can bring me from the sector of excitement to the sector of feeling relaxed. The oscillations can also happen to move me to a state of more or less arousal. When in the unpleasant zone, the direction changes: positive thoughts are those that come with less arousal, so I become less anxious, and negative thoughts are associated with higher arousal and more anxiety.

The movement from one state to another seems to be influenced by how or

what I am thinking. With the flowers for example, while constructing the idea 'I see nice flowers' I experienced positive thoughts, a fraction later I asked myself 'Are they really? So what?', questioning my idea and I experienced the negative thought of 'Would I want them in my house? No, they would not fit in my rooms'.

I will call this flux of positive and negative thoughts that move me from one state to another 'oscillations'.

In his book 'Being a character – psychoanalysis and Self Experience' (1997), Bollas, an influential contemporary psychoanalyst, introduced the term *oscillating states* as a switching between the immersive state and the complex reflective state which he calls 'modes of engagements'. Bollas argues that these modes are interdependent and that oscillating between these states is unavoidable as it enables a person to process life. He states that

"All self experiencing involves this split, which can be described as a division between ourself as simple selves (when we are immersed in desired or evoked experience) and ourself as complex selves (when we think about experience). Naturally such distinctive states may overlies one another, so that I may be reflecting upon an experience in the immediate past while another

part of me is already deep within a disseminating experience.”

(Bollas, 1997, pp4, 15, 27)

He describes a disseminating force as the force that moves us to places beyond thinking. It is this force that moves us from feelings and thoughts in unconscious actions – where the objectifying self is dispersed into elaborated subjectivities- to condensing into a transcendental dialect (Bollas, 1997, p17).

Another source that mentions experiencing a flux of thoughts that moves a person from one state to another is the Bhaghavadgita, or Gita in short.

The Gita originates from around 3100BC and offers a discourse between Lord Krishna and Arjuna on a battlefield on the eve of the battle with members of Arjuna’s family. The conflict is a metaphor for the inner conflicts of human psyche. Interspersed throughout the book there is contemplation about moral issues and teachings about the nature of human beings based on the principles of Hindu religion. The work introduces the notion of three *gunas*, i.e. *sattva*, *rajas* and *tamas*. These are three intertwined qualities and at the same time the three forces of nature. They ‘function in a state of constant flux and change, eternally at work in nature and also in man’ (Sinha, 1987, p29). Each of these *gunas* possesses a distinct and separate quality of its own.

Sattva: “is characterized by harmony, equilibrium, perfection, clarity, goodness, quietness, and illumination. In man, its presence is demonstrated

by knowledge, virtue, and the possession of power”. It is the light according to verse 5 of Krishna (Sinha, 1987, pp 29, 103);

Rajas: “is characterized by activation, mobility, stimulation, passion and pain.

Rajas is understood to be the source of all activity. When a man is dominated by this quality, he is on the move most of the time, engages in restless effort, and seeks a life of enjoyment which results in pain. Unless opposed by other *gunas*, it creates disorder and suffering “. It is the fire according to verse 5 of

Krishna (Sinha, 1987, pp 29,103). *Rajas* form the upward part of the

oscillations, with increased intensity of emotions and a surge of energy;

Tamas: “is characterized by heaviness, darkness, torpor and insensibility.

When dominated by *tamas*, a man resists activity and is indifferent and

apathetic. He is lazy dull, and ignorant”. It is the darkness according to verse 5 of Krishna (Sinha, 1987, pp29,103). *Tamas* form the downward part of the

oscillation, the ‘Is this so? So what?’ questioning.

In a manner similar to Bollas’ ideas of immersive and reflective states, *gunas* dominate, support, activate and interact with one another. They are opposed to one another and are therefore in an eternal process of transmutation.

Whereas Bollas gives a description of these oscillating states, I found the *gunas* offered me an explanation, another image to make sense of the phenomena I was identifying within myself. This will be explored later in this chapter. I also found the distinctions of the *gunas* coming to mind in

situations in ways that helped me alter my behaviour. Further exploration of this and an example is given in Chapter 5.

Looking at the size and direction of the oscillations

The image of oscillations shows a variation in amplitude. They alternate between increasing and decreasing intensity of felt arousal, in height and slope. This slope represents the magnitude of the burst of energy. Using vocabulary of the *River of Energy* to describe this phenomenon of difference in amplitude I could talk of a rapid versus a trickling of water, a deep pool versus a shallow stream bubbling over small stones, a vast river slowly moving at its estuary versus a narrow glacier stream running down the Alps.

In the diagram, the area around the origin is a zone with low energy fluctuations and low felt arousal. The oscillations are smaller because the potential height of the oscillations is limited by the low-ish boundary, hence the potential magnitude is smaller as well. Using a similar argument, the further away from the origin, the bigger the oscillations can potentially be because the potential height is greater.

The direction of the energy movement can be partly explained by Apter's reversal theory on motivation. Apter argues that the basis of motivation is that we want opposite states of mind at different times. The state of mind we

want is of an other mode *and* other intensity, and is thus multimodal (Freud argued it was unimodal), hence motivation is multimodal. This theory provides a partial explanation of the direction of energy movement, and this is also where my enquiry is different from an enquiry into motivation alone. Although I may have the motivation to move to a certain state, it does not mean I will succeed as something might stop me in the path I would take resulting from my motivational forces. Mandler discusses this interruption. He talks about a schema in your head that produces an action sequence with activation resulting in planned behaviour. He argues that although we have the in-built tendency to complete this planned behaviour, interruption can occur by a blockage which happens because of discrepancies between what was expected and what was perceived. The interruption results in that there are no completion plans anymore, manifested by physiological arousal of for example muscle tension or rapid heartbeat. The meaning of the interruption is then evaluated by the individual and the result of this evaluation interpreted as surprise, frustration, joy or some other emotion (Mandler, 1989, p13).

What I am interested in is thus not only the energies involved in the motivational forces, but in what underlies these emotional forces and more generally what underlies any forces that result in energy transformations. I am interested in what determines the height and the size of the height, what determines the distance and the direction of that distance on the 'nature of

intensity' axis?

The felt arousal might be (partly?) explained by the speed or rate of the oscillations, by their slope. Sometimes, the change of states happens slowly and I show little visceral response. At other times, the change of states happens very fast and I might find myself shouting, or throwing things. In this case, strong emotional responses are provoked.

Limit of the intensity of emotion and pain

I noticed within myself that if I experience extreme ugliness or beauty, there is a point after which I switch off and ignore the whole situation. Sometimes this comes with physical manifestations such as crying, feeling sick, shouting, sometimes with turmoil in my head, at other times with feeling slightly disturbed.

Does this mean there is a threshold to beauty and ugliness? Can a notion of maximum beauty exist? How is it I can experience something as utterly and perfectly beautiful and a little while later I experience it as 'pretty'?

These moments of 'maximum' beauty or ugliness happen when I feel a high intensity of emotions for that situation. It seems therefore that it is not the beauty that has a limit, but the intensity of my emotions. The highest level of beauty is determined by how much arousal I can take at that moment. Some

moments I can cope with high arousal, some moments I cannot. The amount of arousal felt happens during this *process of perception* of beauty or ugliness.

Gattegno made a remarkable, seminal contribution to the understanding of the learning process at all ages. In his book 'The Mind Teaches the Brain' (1988), Gattegno talks about what happens in the process of perception. He argues that one of the dimensions of perception is the link of any feeling to a value system which we experience as beauty or ugliness and that might come with thresholds. He states that

“There is perhaps a pair of individual thresholds for any feeling within which the self acknowledges a perception that goes to making sense of beauty”

(Gattegno, 1988, p302).

Although Gattegno reasons that these thresholds are created and adhered to by 'social habits and etiquette' and that adherence to them offers 'the capacity to be shocked, to blush, to feel attacked and hurt' (Gattegno, 1988, p303), I argue there are other, more individual aspects involved in the threshold of maximum arousal as well. For example, during a lesson observation a student said to me, with 'she' referring to the teacher whose lesson I was observing:

“It’s boring; I can’t do this; I can but I don’t want to; I want to go home; she knows we can do this already”

There are many ways to interpret this, but given the context I choose to interpret the student’s utterance ‘I want to go home’ as the ‘fight or flight’ syndrome. At that moment, he cannot take any more. He has reached his threshold. This might be because of social habits and etiquette that says you should not become noticeably emotionally upset in the classroom. It could also come from experiencing pain and not being able to suffer more.

Sometimes this pain is physical, and when there is too much pain and I cannot cope any more I will faint. Sometimes the pain is emotional.

The *guna rajas* in people is described in the Gita as being a potential source of pain, disorder and suffering if not opposed by other *gunas*. *Rajas* corresponds to the upward part of the oscillation, the part that comes with higher arousal and that can push to the threshold of maximum arousal. The student in the class could have reached his maximum emotional pain level at that time when he wanted to go home.

Hence, I argue oscillations happen in the process of perception of the nature of the emotion, in the process of making sense. The oscillations are the force or the energy behind the moving states. At times, the ‘*rajas*’ leg of the

oscillation pushes the state to the boundary of the maximum arousal. This boundary is determined by social habits and etiquette and by individual levels of experiencing pain. Ultimately this boundary is limited by how much you can take physically, when will you faint, when will you get a heart attack. This is the point where the boundary line levels out and becomes horizontal. Any other points on the boundary describe the maximum you can take emotionally. This will depend on the situation. For example: I notice the shape of an old oak tree. I consider it beautiful. My awareness and presence increases and I notice the shape of the tree. My arousal increases and I experience a surge of energy. I start noticing other things of beauty as well. My increased awareness leads me thus to increased noticing which moves my state to higher intensity of emotions in this case. I have been experiencing *rajas*-direction energy, being fully immersed in the beauty of this tree. I have moved to a state of excitement. I grin. I laugh. I have not questioned ‘So what?’ And then I suddenly feel ridiculous laughing about a tree. I have reached my boundary. Hitting the boundary results in *tamas*-energy, in becoming reflective. The state I ended in was in the ‘unpleasantness’ zone. Can I argue that I had hit the boundary? Was this not just a question of moving from immersive to reflective state? At this moment I think what is different is that when bounced back by the boundary, my focus of attention is on a different subject. This does not need to happen when I do not hit the boundary. Different effects of such disturbances will be addressed in

Why is this graph image of energies and emotions and its implications important in mathematics classrooms or in other words, what is its relevance?

I noticed that being aware of this diagram made me vulnerable to emotions, intensities and the energy present in the oscillations. I developed my sensitivities to these in the teaching and learning of mathematics. Gattegno captured this process by writing

“The self is capable of adding sensitivities to its endowment by making itself vulnerable to some functioning of itself, by making itself aware of the existence of such an opening and cultivating it. Vulnerability is an active movement of the self, permitting some kind of energy change to be noted and a flow of energy to be maintained. This capacity we shall describe as dwelling in. Awareness is required for noting, but vulnerability results from maintaining the presence of the self, or awareness, in what was noted “.

The diagram offered me a way to ‘dwell in’ analysing energies and emotions and to manipulate the states my students and I are in, which is described next.

Why is it useful to be able to manipulate these states

Out of necessity because of the effects of affect on learning

The effects of affect on learning have been recognised and researched by many researchers in the last hundred years. Mandler confirms this and writes

“There is now a burgeoning body of evidence that emotional states interact in important ways with traditional cognitive functions”

(Mandler, 1989, p4).

He offers a summary of influential research findings on this subject and mentions amongst others Yerkes-Dodson (1908), Easterbrook (1959), Isen, Means, Patrick & Nowicki (1982) (Mandler, 1989, pp3, 4).

The Yerkes-Dodson law states: “the relation between stress and efficiency of learning was curvilinear – worst at both weak and strong levels of stress and best at intermediate levels” (quoted in Mandler, 1989, p3). Easterbrook wrote

“... our attentional capacity for picking up information is increasingly impaired by increases in emotional intensity”

(quoted in Mandler, 1989, p3)

In order for students to learn, teachers and ideally students themselves, have to be able to manipulate their emotional states, or at least be aware and have some understanding. This is especially important for maths, as there seems to be so many emotional responses to the subject. Not only do emotions have an effect on the acquisition of knowledge, but Isen *et al* have also shown that

“positive feelings determine the accessibility of mental contents in the process of decision making, serving as retrieval cues, and influence problem-solving strategies”

(quoted in Mandler, 1989, p4)

Because affect influences the learning so profoundly, it is important to be able to move students to states where the affect does not hinder and preferably helps the learning.

The following examples originate from classroom observations made of two teachers in the Improving Attainment in Mathematics Project. The teachers

are very different in personality, in experience and in mathematical background. They use different kind of tasks to move the students to the states the teachers want them to occupy.

An illustration from Camille's classroom: the journey

Camille offers her students 'body multiplications' at the start of the lesson. She considers this very important. The activity moves the students from whatever state they are in when they enter the classroom to a state of feeling pleasant and excited, with high arousal. In her teaching of mathematical concepts that follow on from such activity, she often uses personal examples of situations that have happened to her and with which her students can identify themselves to a certain extent. Here follows the transcript of part of the lesson where she uses elaborate examples in a lesson on directed number. She talks about a journey she had undertaken to Wales and how she noticed that the temperature had changed the moment she went over the Welsh border.

T: Yesterday I did some driving, I did, I did lots of driving in fact, I did loads and loads of driving, and I noticed something very odd, and I was driving along, and the car (children talking in background) - you're being very silly today (directed at a particular pupil off camera)..I was driving along and the car, the

thermometer had a temperature reading on it, on the dash board, and I kept looking at this from time to time, and it was twenty degrees in car, so that was really quite nice, I felt quite comfortable, and I was dry, I had a thin jumper on but I was driving, I was quite happy and quite comfortable so it was twenty degrees. But outside, as we travelled it was quite warm when we started but as we travelled along it went down to thirteen....

Pupil (Unprompted and off camera): Is it because you going faster as you were going along which caused you.....

T: Well it could because of that, and I want to talk to you about that actually. But it was also getting colder outside.

(Different) Pupil (Unprompted and off camera): 'Coz your engine was warm and it warmed the car.

T: No, we had to put the heating on inside the car, but I was thinking about, it's gone down to thirteen outside, how many degrees has it dropped?

Pupil (off camera): What was it in the car?

General murmur of noise, then, Pupil: 7?

T: It had gone down 7, yeah. It had gone down 7. So, it had gone from twenty, down 7 to thirteen. And as I was driving along, I noticed something very odd, we decided that we'd would pull off the M6, and we'd come down along the coast, we noticed that it

was 29 miles to my parents and we'd drop in a see them and so we took a little bit of a detour, and we noticed that as soon as we crossed the border in Wales, the temperature changed, OK. The temperature changed in Wales and I didn't notice, and I didn't think that there was anything particularly odd about that on the way there,its cold there is it (addressing a pupil who had muttered something to her that the video did not pick up)? ... but it was just the border, I mean the borders like one little bit's England and then next bit's Wales and there's a temperature change as you go over the border, and then we drove around Wales and the temperature was still the same, and we drove a little bit further and as soon as we crossed back over the border, it said Shropshire, Welcome to England, the temperature went back up again! (some laughing)

Pupil (off camera): It was something to do with the sign..

T: It was something to do with the sign, it was very, very strange, but the temperature was five degrees different outside, it got five degrees colder outside, what had the temperature gone to, so, it had dropped by five degrees, what had it gone to?

Pupil: what was it.....?

T: What was it outside originally? OK, It had gone down by five degrees....(pupils with hands up on screen)...15? What would

have happened if it had gone to 15?

Pupil (off camera): it would've gone up

T: It would have gone up wouldn't it?

Pupil (off camera): 8

T: 8. So, it's eight degrees outside. It was very, very odd. I was wondering if, you know, I went outside and it hadn't done that, and we drove a bit further into Wales whether it would have dropped another five degrees, what would it have been then?

Pupil (off camera): Two

Pupil (off camera): Three

T: Three. And what would have happened if it had dropped again?

(General talking amongst pupils)

Pupil(off camera): Minus two

T: It would have been minus two

Pupil (close to camera spoken quietly): then minus seven

T: And again!?

(General talking amongst pupils)

T: Shh! What was that. (snaps fingers) Listen. What did you say?

You said minus one, Liz what did you say? ... (mumur) yes you did you said one, you said one....that would go back up again well done (to another pupil). So it was going back up again, so what would it go down to then?

Pupil (off camera): Minus seven!!

T: Minus seven, and then again?

Pupil (off camera): Minus twelve

T: Minus twelve. It would be a pretty cold day, I'm glad it didn't get that cold outside because I would be freezing!, if I had to get out, I'm glad I was in the car really.

Asked about her rationale, Camille said she used such examples, because

- It is a real story, it is reality.
- Hopefully the students can relate better to it.
- It has a beginning, a middle, a climax; i.e. the features of a real story

Camille also thought the example builds a more complete picture, including emotions, so

- Students can identify with the story, put themselves in the same situation.
- Develop a sense of empathy by the students with the teacher and the situation
- The example brings up emotions [which lead to empathy]
- You work with all kind of learning styles (kinaesthetic, visual, auditory)
- These examples are good explanations, not just the maths which they

don't get.

- It is not just about the maths, for example the sum, but about why the sum works, why it is there. It is about the understanding behind it

By choosing such personalised examples, Camille manipulates the states of her students. After the 'body timestables' which she offered to take her students to a state of feeling pleasant and excited, with high arousal, she continues keeping her students in this state of pleasantness and excitement by offering a story that includes a sense of suspense and surprise. The atmosphere in the classroom is of feeling good and excitement.

As described earlier in the example 'An illustration from Alexandra's classroom: multiplications', Alexandra approaches things differently. She manipulated the states of her students to a neutral and low arousal mode by giving them a very structured and disciplined task. By giving rewards for personal improvements and by creating a sense of suspense by incorporating a time limit in the task, she moved her students to the pleasant zone with slight arousal.

Both teachers manipulate the states of their students by the choice of task and pedagogy. This choice of task and pedagogy forms an 'object' that moves the students from one state to another. Bollas uses this notion of objects

“In this respect, the objects of our world are potential forms of transformation. When we select any series of objects - such as listening to a particular record, then telephoning a particular person, then reading from a particular book - we transform our inner experience by eliciting new psychic textures that bring us into differing areas of potential being.”

(Bollas, 1997, p4)

To move from reacting to responding

Another reason why it is useful to be able to manipulate these states is to allow myself, the teacher, to move from *reacting* to *responding*. By *reacting* I mean intuitively reacting to something that occurs, without time for reflection, without requiring awareness. *Responding* requires pausing to think, a certain level of awareness and comes with a sense of choice.

Because I have made myself vulnerable to being aware of emotional states, I find I can discipline myself in noticing such states. As a result, I find I am no longer triggered into a reaction. And because I now have the belief that emotional states can be manipulated, I find myself looking for other components of emotional states such as physiological manifestations. As such, I can indeed move myself from reacting to responding in classroom

situations.

The example that follows describes how at a certain moment I became aware of being in the unpleasant zone of the diagram and that I did not want to be there. The mental image of the diagram offered me a choice: moving further along the unpleasant path or moving toward the more neutral origin, possibly followed by moving to the pleasant zone. Not doing anything might have been easier, because I would not have had to look for objects to manipulate my states. To find a suitable object I had to start thinking ‘How can I look at this situation differently? Can I find something beautiful in here?’

Macy – a classroom example from my journal

Macy has been getting on my nerves over the last couple of weeks. She is an able mathematician, 14 years old and not in the mood for working at the moment. On top of that she chooses to sit right in the middle of the classroom so she is always in my view. Every time I look at her, she is not working. And because of where she is sitting, I always see her, constantly, not working. Students who are not working disturb me. Seeing it constantly greatly disturbs me and I make constant remarks to her to keep her on task. Macy says I am picking on her. She is absolutely right. But I cannot ignore her. I am aware that I am in the unpleasant zone of my

graph and I get more and more agitated, and it is not constructive. It is getting rather confrontational and the atmosphere in the class is changing. I take a decision I want to move to the pleasant zone. First I have to cross the neutral zone. To do that, I decide to put all the girls in set places, placing Macy in the back left hand corner of the class, out of my general view, so I will not be confronted all the time with what she is doing. I also place her next to Samantha, bright, very hard working, with a good sense of humour and a friend of Macy. From the first lesson, I notice that indeed, I do not 'pick ' on her that much anymore, because I am not confronted every time with seeing her not work. This carries on for about 5 lessons. I become aware that Macy is slowly gaining trust in me again, she is becoming willing to answer questions, to volunteer information, to share her ideas, but not yet to come and ask me for help. I have become more relaxed, not always on the look out, more free, because I feel I do not have to intervene every time to keep her on track.

Being in a more neutral zone, I have the freedom to ignore Macy if I want, to get on with how I want to teach. Because she is becoming more active in the class and participating, I am aware I am slowly moving into the positive zone. She is starting to fulfil

my expectations. It is a very pleasant feeling, and I notice I start to smile at her again. I decide I want to move further down the pleasant zone. I know I have to confront my fear: I will have to observe whether she is working. The danger is that if she is not, what will I do? I do not want to get into that 'unpleasant' spiral again. I have got one big advantage: I can make a conscious decision when I look at her. I do not have to do this if I do not want to or if I do not feel it is the right moment. I choose my moments to look. Good moments are when there are no other demands on me to do something, not from other students or myself. When I look, she is not always on task. Because I wish to move in the pleasant direction, I am aware that I have to stop seeing the general, i.e. Macy is not on task. I am starting to focus on detail, on the particular. One lesson, I notice Macy is trying to distract Samantha and that is not an easy job, because Samantha just works. And I focus on the techniques she is using to distract Samantha. On her body language, on her gestures. She tries to chat, leaning over to Samantha. Samantha says something back, I think to the extent of 'I am working', because Macy moves back sitting straight in her chair. She keeps looking at Samantha. She turns her body towards the window, as if something interesting is happening outside. Samantha does not react. Macy turns back to

sit straight. She must be really thinking about this. She has not noticed I have been looking at her the whole time. Some of the girls have noticed it and are looking at Macy as well. It is getting rather comical. Haha, Macy thinks of something else. She slowly moves her whole arm, not just her hand, over Samantha's exercise book. Bingo! Samantha looks at her and laughs. They chat together. Then Samantha notices the other students and I are watching. Macy looks up as well. I have to laugh. Macy turns red in the face and smiles with a grin. And she goes to work. Since then, when Macy is not working, which does not happen so often now, I look at her and when she looks at me, I tend to smile and shake my head. In most cases she goes back to work. She also feels more comfortable with me, coming to me and sitting next to me, to discuss her work. Her body language is relaxed. At times, she even 'lounges' over my desk, body bent over the desk, arms supporting her upper body.

Because I was aware of where I was on the graph and where I wanted to go on the diagram and because this awareness offered me the knowledge that I had a choice in how to manipulate the emotional state I am in, I managed to change my perspective of the situation and move to the desired state.

The object that had caught me and kept me in the unpleasant zone was Macy being constantly in view and not working. By removing this object via replacing it with a more neutral object, i.e. the observing of Macy's body language and how she was relating to other students, I became a more distant observer. From my observations I could see the humour in how she was trying to distract her peers. I smiled, and this re-inforced the 'pleasant' feeling. This feeling of pleasantness pushed me into further pleasant thoughts and I found myself thinking "Gosh, this is a really inventive way of trying to distract somebody". The choice of object involved focusing on the particular, moving away from my general observation of 'annoying Macy'. I was able to stop labelling the behaviour and think about what she was actually doing.

I have used my graph to move from reacting to responding. When reacting, I am triggered into another state over which I have little or no control. My awareness of the diagram seems to have offered me a framework of 'Where am I? What is going on?'. It offers me a separation from the triggering effect of a situation and I can move from reacting to responding.

Summary of this chapter and link to further chapters

In this chapter I first described how I worked on becoming aware and

developing sensitivities of energy dynamics, how I made myself vulnerable to these notions. I thus became aware of emotional states having a direct effect on energy levels and developed my sensitivities to these in the teaching and learning of mathematics.

I created a mental image of this in the form of a diagram that allowed me to make a distinction between emotions and energy, to explore their co-existence and interactions.

The diagram helped me make sense of the interrelation between emotions and energy in terms of quantity, direction and nature. I was inspired by Mandler, Apter, Bollas and the Gita to find a vocabulary and a conceptual framework to illuminate this phenomenon within me, to relate this to cognitive processes while at the same time not separating them from emotions as approached in non-cognitive psychology and psycho-analysis.

I used Mandler's description of emotion to identify two of its characteristics. I illustrated how Apter's classification of 'states of mind' helped me to analyse and describe incidents in the classroom. I explored how I move from one point on the graph to another point, in oscillations and used ideas from Bollas and the Gita. By looking at the size and directions of these oscillations I further incorporated ideas from Mandler and Apter and argued oscillations happen in the process of perception of the nature of the emotion, in the

process of making sense.

The diagram helped me to become sensitive to issues relating to emotion and energy, and guided me first in the understanding, and later in the manipulation of emotions and energy manifestations. It allowed me thus to manipulate energy levels and the effects of affect on learning and teaching and helped me, the teacher, to move from reacting to responding in my classroom.

In this chapter I have explored being in, and manipulating, an emotional state and its associated energy. The question I ask myself is how did I get in that state? I argued moving from one state to another happens in the process of making sense of an input that triggers me into such state. But how does it work? What else is involved? What is causing, driving and generating these emotions and energy dynamics? Why do they shift? What lies beneath these energies?

Chapter 4 will look at what happens in *the process of making sense* as many of the issues raised in these questions seem to take place in that process.

Chapter IV Making sense

In the previous chapter I have taken an initial look at how the nature of emotions interrelates with the energy intensity of emotions experienced as felt arousal. The diagram I developed offered me a mental image of their interaction which in turn allowed me to explore manipulating both energy and the felt arousal of emotion within myself and with my students. I conjectured that being in a state is the result of having made sense of some input that triggers me into that state.

In this chapter I will continue my journey on the River of Energy and explore where it takes me in *the process of making sense*.

What is making sense?

The Oxford Dictionary (Elliot, 1997) explains

to make sense as ‘to have a meaning that you can easily understand’;

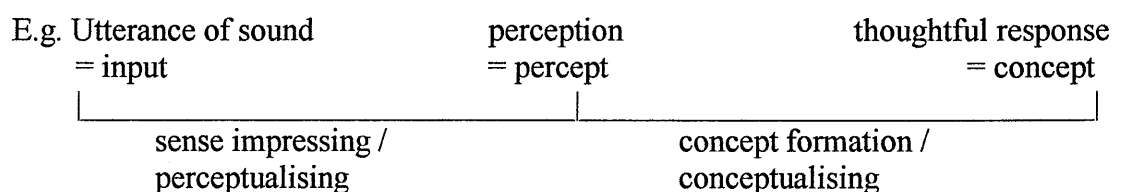
to understand as ‘to comprehend, to perceive meaning or significance’;

meaning as ‘significance’;

to perceive as ‘to become aware of by one of the senses; apprehend; understand’.

My first impression is that *making sense* involves some action, unconsciously or consciously in giving a meaning, which is about finding significance, purpose, or function. The time duration of the making sense process continues until this meaning is *easily perceived*, i.e. until it fits in a thinking frame and no hard thinking is required any more. Action requires energy and could involve energy transformations. These energies can guide me on my journey and offer me opportunities for exploration.

Descriptions of the *process of making sense* in academic literature make a distinction between perceiving and conceptualising, which I consider next. Literature about perceptualising that I will discuss in this thesis include the views of Gestalt psychologists, the Gita and of constructivists. Literature about conceptualising that I will discuss in this thesis include the views of Minsky, Vergnaud, Gibson, the Gita, Lacan, Bruner and Mason. For the purpose of clarity I will define the period of *making sense* in this thesis as follows:



The *process of making sense* starts from the moment or point of input via the moment or point of percept to the moment or point of concept.

The point of input is the moment when the input is presented. The input can be anything that can be perceived by senses such as hearing, smelling, seeing, feeling. It could be for example a text, an object, a drawing, a smell, a colour. The input triggers me into a flow of energy that allows me to perceptualise and conceptualise. Why this happens will be explored later in this chapter.

The point of percept is the moment when the senses that received the input have impressed an object on the mind. There is a sense of appearance of the object, an impression, but no deeper identification has happened yet, no mental meaning has been attached to it. There is an awareness that something is present.

The point of concept is the moment when there is a thoughtful response, when a mental formulation of the object has taken place.

The period between these points is when action takes place.

The period from input to percept is called *impressing* or *perceptualising*.

In this period the input is received by the senses (sight, sound, taste, smell, touch) through a physiological process. The senses impress an object that has been received. This is the stage where you find yourself seeing shapes, smelling smells, hearing words and where an awareness that something is present is surfacing. There is a sense of appearing of the object, an impressing, but no deeper identifying is happening yet, no mental meaning being attached to it.

The period from percept to concept is called *conceptualising*. In this period a mental formulation of the object is taking place. The object is being thought about, consciously or unconsciously, and an idea, a notion is forming. An identification process is taking place. In this period you think about the object and identify it, linking it to past experiences in the process of identification.

Literature about the process of perceiving or impressing

The Gita describe the process of perceiving as: ‘the senses perceive objects without interpretation or judgment and bring such percepts to the mind’
(Sinha, 1987, p30)

Gestalt psychologists developed from the early 20th century a theory of

conceptual organization and a theory of perceptual organization based on physiological fields in terms of analogous brain processes (Gardner, 1985, pp112, 114). The first mention of Gestalt phenomena was made by the Austrian Von Ehrenfels in 1890. Weitheimer, who is considered the Founder of Gestalt published a paper on the visual perception of movement in 1912. Gestalt theory has been criticised on the grounds that some of the assumptions may be incorrect in their theory of conceptual organisation, such as the assumption that the verification of the laws implies that the Gestalt model of brain events is correct. However, the laws of grouping in Gestalt Theory seem to have been upheld (Rock, 1975, p290, 291).

In this Chapter, I will focus on the perceptual organization where Gestalt psychologists propose several laws of grouping which describe how input is compiled by the mind in the perceptualising or impressing stage. They used descriptions rather than explanations. The initial laws of grouping were formulised by Weitheimer and his colleagues Koffka and Köhler and summarised more recently by Eysenck and Keane (2000, pp25-29, 50) as:

Law of Pragnanz : this is the fundamental law of the Gestaltists and developed by Koffka in 1935. It says: “of several geometrically possible organizations that one will actually occur which possesses the best, simple and most stable shape” (Eysenck and Keane, 2000, p26)

Law of proximity: visual elements tend to be grouped together if they are

close to each other.

Law of similarity: elements will be grouped together perceptually if they are similar to each other.

Law of good continuation: those elements requiring the fewest changes or interruptions in straight or smoothly curving lines will be grouped together.

Law of closure: missing parts of a figure are filled in to complete the figure.

Law of common fate: visual elements that seem to move together are grouped together.

What these Gestalt laws tell me is that the unconscious turns the original input into something that can be rather different and the mind supplements this original input with other elements to make it into something that is then impressed on the mind and becomes the percept. There is an inert wish for perceiving a stable shape in me and I unconsciously make allowances to turn it into such a stable shape. Using these laws, my mind is making assumptions of grouping, of completing, of selecting, making it a whole (law of closure). Hence within me there is a tendency to cut out and ignore de-stabilising factors in order to make things stable.

While Gestaltists are very specific in what is happening in the process of perceptualising, **constructivist** theories are not so different from the Gestalt laws. Von Helmholtz (1821-1894) was one of the first constructivists. He

argued that in the process of perceptualising meaning is added to sensory information in the form of *unconscious* inference. This is necessary because there is insufficient accurate information in the scenes that have been observed (Gardner, 1985, p296). The contemporary constructivist Gregory supports the assumptions resembling those originally proposed by Von Helmholtz and depicts perception as an “*experience of the world of objects*” (Gregory, 1973, p219) implying the importance of memory, of constructions of the past. He describes the process of perceptualising as

“Perception is not determined simply by the stimulus pattern; rather it is a dynamic searching for the best interpretation of the available data....The senses do not give us a picture of the world directly; rather they provide evidence for checking hypotheses about what lies before us”.

(Gregory, 1973, p11)

Hence, in the process of perceptualising an impression of the input is made on the mind. Both Gestaltists and constructivists argue that in that dynamic process information is unconsciously added to the input to make it into the perceived input, called the percept. Constructivists claim this information comes from our memory, not through thinking but through the senses signalling small bits of data. The Gestalt organizational theories of perception are explicit in their laws which explain what information is actually added and

where your attention is being focussed, but do not address where this information comes from. I would argue that these theories do not contradict but complement each other and I advocate a combination of the two.

To illustrate what happens, I will describe the interpreted perceptualising process I experienced going through when I saw this picture in the ClipArt collection on my computer. Interpreted, because this process is supposed to happen at an unconscious level.



I experience an input being received by my eyes – colours, shapes and lines. I can't distinguish any objects straight away. I am trying to make sense of the picture by (unconsciously) identifying them, linking them to existing experiences. Conforming to a constructivist view I am scanning my brain memory banks to find a clue of what it could be. I can distinguish a heart shape. I can't see anything else yet. In order for me to make sense of the rest of the picture I have to scan my memory bank for some resemblances in past experiences. While doing that I look at the picture and according to Gestalt laws I find myself following lines, grouping lines together and ignoring other

ones. I stress and ignore. I find I am adding colour to certain lines to make it into a whole picture. I group and re-group. Suddenly I 'see' a stethoscope and zig-zag lines. At this stage I have not made any judgment on the percept that has been brought to my mind by my senses confirming what is stated in the Gita: I have no thoughts about whether I like it or not, no thoughts that it could have a symbolic meaning, it has not made me re-live experiences I have had with stethoscopes, hearts and zig-zag lines.

Literature about conceptualising

The Gita describes the process of conceptualising as:

'[the mind] synthesizes them [the perceived objects] and takes them to self-awareness (ahamkara), which in turn refers them to self (purusha), and as objects of self-consciousness they come before intelligence (buddhi), which ascertains their nature.' (Sinha, 1987, p30). The identification of the object happens through deduction and conclusion, referred to as inference, which in its turn is derived from experience (Sinha, 1987, p31). It is based on analogies once it concerns knowledge of things beyond the senses. The Gita categorizes this inferring, or deduction and conclusion, in three distinctive groupings, the distinctions made being obtained from time positioning between the object and the analogy triggered. The examples given with each category come from the Gita, at the end there is exemplification from the

classroom.

Inferring based on antecedent (purvavat): e.g. 'by seeing the rising clouds, rain is inferred through antecedent inferring' (Sinha, 1987, p31).

'Antecedent' is described in the dictionary as 'preceding thing or circumstance' (Elliot , 1997). Seeing the rising clouds triggers the analogy of the preceding circumstance that it has rained, because this is what past experiences tell me.

Inferring based on subsequent (sheshvat): e.g. 'by tasting some milk from its container, the quality of the milk is inferred through subsequent inferring' (Sinha, 1987, p31). 'Subsequent' is described in the dictionary as 'following specified event' (Elliot , 1997). When tasting milk, a percept of the taste is formed and triggers the analogy in my past experiences of tastes of milk and subsequently attached norms for its quality. It is this norm that is inferred.

Inferring based on analogous (samanya): e.g. 'by noticing apple trees in blossom at one place, it is inferred that apple trees elsewhere have also blossomed through analogous inferring' (Sinha, 1987, p31). 'Analogous' is described in the dictionary as 'partial similar or parallel' (Elliot , 1997). The percept formed by seeing is noticing the apple trees in blossom, which triggers an analogy in my past experiences of knowing that apple trees blossom simultaneously.

An example from the classroom to illustrate these categories of inferring:

Tom is one of my bright and hard-working students. He works fast, gets to tasks without delay and is responsive. I had set the class a written task and walking around the classroom a little while later I find that Tom had not written anything yet. The percept here is noticing that Tom has a blank page. Using the Gita's categorization I can infer this in three different ways:

Noticing the blank page triggers the analogy in my past experiences that Tom had not understood the task which resulted in this blank page. This would be inferring based on antecedence.

Noticing the blank page triggers the analogy in my past experiences that Tom will not write anything in the coming time span unless I interfere. This would be inferring based on subsequence.

Noticing the blank page triggers the analogy in my past experiences that as Tom has not written anything yet, neither will many of his peers in the class. This would be inferring based on analogy.

Minsky is an American mathematician and computer scientist and one of the founders of robotics and artificial intelligence (AI). He saw many common points and interaction between the neurosciences, psychology and Artificial Intelligence, and in the early 1970s began formulating, initially together with Papert, a theory about the organization and workings of the mind, combining insights from developmental child psychology and AI. Minsky belongs to the school that see the mind as an information processing system that employs

schema's.

Most references to Minsky in this thesis come from his book 'The Society of Mind' (1988, first published 1985) which sets out this theory and contains interconnected one-page ideas on his identified psychological phenomena.

Minsky mirrors the discussion in the Gita when he argues that connections are based on past experiences. He says 'we're always learning from experience by seeing some examples and then applying them to situations that we've never seen before' (Minsky, 1988, p203). Minsky's view of how perceptions are recognized and identified in the process of conceptualising is based on a system of what he calls *polynemes*. He describes a polyneme as 'a hypothetical neuronal mechanism for activating corresponding slots in different representations' (Minsky, 1991, p5). In his description of the process he uses a concept of 'agencies' such as taste agency, physical structure agency, substance agency, whose inputs come from memories instead of from the sensory world. The combination of all these agencies activate one of [a person's] polynemes' (Minsky, 1988, p204).

In his influential work on multiplicative reasoning, Vergnaud found it helpful to coin the term 'conceptual fields' in order to specify the range of ideas that contribute to or play a role in multiplicative reasoning. The term is now used in connection with other mathematical topics. He describes how a conceptual

field is made up of a set of problems which require similar thinking by saying:

“A conceptual field is a set of problems...for the treatment of which concepts, procedures, and representations of different but narrowly interconnected types are necessary”

(Vergnaud, 1983, p127).

I think Minsky and Vergnaud are talking about the same thing. In his elaboration on the ‘concept of concept’ (Minsky, 1988, p105) Minsky explains that concepts are formed and grouped by humans by trying to combine related agents first. He does not really give a definition of what these related agents are, but gives a description and some explanation as to why they could be related neurologically. As illustration of closely related agents he uses the example of ‘tall, thin, short and wide’ and argues that these are related agents ‘because they are all concerned with making comparisons between spatial qualities. In fact, they probably involve agencies that are close to one another in the brain and share so many agents in common that they’ll naturally seem similar’ (Minsky, 1988, p105). Making comparisons between spatial qualities requires, as does Vergnaud’s conceptual fields, collectively grouping of experiences based on similar modes of thinking.

Hence, the views of Minsky, Vergnaud and the Gita have several things in common. All refer to a system that is triggered by the percept that is based on looking for analogies in past experiences. The Gita typifies these in three possible categories, based on a kind of time-frame in relation to the object and its analogy triggered. Minsky talks about agencies which look for analogies of the object according to one of its characteristics, then the findings of these agencies together are put together and form a polyneme. Vergnaud groups his analogies in ways of thinking and each conceptual field has its own method of thinking. At least some of Minsky's 'related agents' could also be categorized as 'conceptual fields'.

The American psychologist Gibson takes another approach and talks about *affordances* of the objects. Although he claims to be talking about perceptualising, I would categorize it as conceptualising, based on the definitions I have made in *this* thesis. In his book 'The Ecological Approach to Visual Perception' (1979), he argues that all the potential uses of objects (their *affordances*) are directly perceivable. Most objects give rise to more than one affordance. The affordance that will be perceived is determined by the perceiver's psychological state in that moment. For example, when I see a pineapple when hungry I will perceive its affordance as edibility and eat it; when I see a pineapple when drawing, I will perceive its affordance as an aesthetic object and admire its structure. Gibson also described how such

identification of affordances works in reverse, how perceiving an object triggers knowledge about the affordances. He uses the example of a postbox:

“The postbox...affords letter-mailing to a letter-writing human in a community with a postal system. This fact is perceived when the postbox is identified as such.”

(Gibson, 1979, p139)

I would call these *functionalities*, because they give a function to the object that functions within the present psychological state. Because it corresponds with the present psychological state I would argue, from personal experience as well, that *not* all potential uses of an object are directly perceivable and that it is those that correspond with assumptions and expectations that come with the present psychological state of mind that are perceived. As Minsky states:

“Philosophers of every period have tried to generalize about how we learn so much from our experiences. They have proposed many theories about this, using names like “abstraction”, “induction”, “deduction” and so forth “.

(Minsky, 1988, p203).

I am aware that what I offer will therefore probably not be new or original in

itself. However, there is a freshness in combining ideas from multiple sources which illuminate experience.

The authors I have discussed so far seem to agree that the perceived object triggers analogies to past experiences. Although the categorisation of these analogies are different depending on the author, they all somehow concern *what you can do with the perceived object, or what activity can be associated with it*, what I call its *functionality*. The Gita places the associated activity in a time frame – before, after or parallel with the perceived object; Minsky talks about agencies who identify its characteristics and then come together in a polyneme; Vergnaud categorizes the associated activities in ways of thinking, in what he calls *conceptual fields*. Gibson is more explicit about this and talks about *affordances*, thinking explicitly of what the perceived object allows you to do with it. The affordance that will be perceived is determined by the person's psychological state in that moment and implies some kind of *situated functionality* as the perceived affordance changes as a function of the psychological state of the perceiver.

Hence, I argue that a functionality of the concept is chosen depending on the context of the object or the perceiver. Change the concept or change the context and the functionality will change as well. I will expand further on this later in this chapter and in the realm of Selves in Chapter 5.

Lacan, the French psychoanalyst, has different interesting ideas on the process of making sense. Many of his insights have percolated into the education community despite his work being complex and difficult to comprehend. His approach to sense making is notably different from the authors discussed so far.

Lacan originally trained as a psychiatrist, and in the 1930s and 40s worked with psychotic patients; in the 1950s he began to develop his own version of psychoanalysis, based on the ideas articulated in structuralist linguistics and anthropology and reflecting his interest in language and linguistics. Lacan's ideas are based on Freud's theory and practice of bringing the content of the unconscious into the consciousness, thereby aiming to minimize repression and neurosis. Freud described the two main mechanisms of the unconscious process as condensation and displacement. Lacan observes that Freud's dream analyses are mainly verbal as they depend on word-play, associations, etc. Lacan deduces that the content of the unconscious is very aware of language and of the structure of language (Lacan, 1986, pp24-28). He considers the mechanisms of the unconscious processes as linguistic phenomena with meaning being either condensed, such as in metaphor, or displaced, such as in metonymy. Lacan thus argues that the unconscious is structured like a language (Lacan, 1986, p20). In Lacanian psycho-analysis the unconscious is the ground for all being, with actions, thoughts, beliefs and making sense being determined by it. Lacan hence places the process of

making sense in the narrative field.

Bruner, psychologist and educationalist, also places this process of making sense in the realm of the narrative on similar grounds, but without emphasizing the unconscious. Similarly to Gattegno, and in line with the methodology of this thesis, he considers educating as becoming aware of thinking processes, expressing and expanding these. He says a language contains an ordered or rule-governed system of signs that is necessary for 'entering meaning' because 'meaning depends not only upon a sign and a referent but also upon an *interpretant* – a representation of the world in terms of which the sign-referent relationship is mediated.¹' (Bruner, 1990, p69). He coins this notion *the biology of meaning* (Bruner, 1990, p69). Other aspects of his view will be addressed in Chapter 5.

¹ Bruner refers to CS Peirce to explain the notions of signs and interpretant:

'A sign, or *representamen*, is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign. That sign which it creates I call the *interpretant* of the first sign. The sign stands for something, its *object*. It stands for the object, not in all respects, but in reference to a sort of idea, which I have sometimes called the *ground* of the representamen. 'Idea' is here to be understood in a sort of Platonic sense very familiar in everyday talk; I mean in that sense in which we can say that one man catches another man's idea' (Peirce, 1960, p228)

Mason is another author who places the process of making sense in the narrative field. He defines *making sense* as ‘accounting for’, which means ‘to justify, to explain why it happens’ (Mason, private communication). He also argues that it is *labels*, another linguistic phenomenon, that trigger connections to past experience and intentions (Mason, 1999, p260).

Placing the process of making sense in the narrative felt like a revelation to me. It offered me a different approach, a different theoretical framework. It was not only that I was entering the field of linguistics; I could now also see the mind as a creator of meaning in addition to the other authors’ view of seeing the mind as an information processor. Bruner describes this more strongly in his summary of recent developments in psychology:

“The cognitive revolution became fractionated and technicalized, with emphasis shifting from ‘meaning’ to ‘information’, from the construction of meaning to the processing of information.

Computing became the model of the mind, and in place of the concept of meaning there emerged the concept of computability.”

(Bruner, 1990, p4)

The combination of these views and approaches led me explore the process of making sense from a new perspective, which I will do next, incorporating

theories and concepts of linguistics, and applying these in the analysis of teaching practice.

Influencing the ‘selecting’ of similarities triggered in the process of making sense

From the previous section I have the impression that much of the current literature argues that the process of conceptualising is based on looking for analogies, similarities and connections in past experiences. The literature largely describes the process of *how* these analogies are triggered. The question for me as an educator is: can I manipulate or influence the selection of these analogies? How does it work in the classroom? What works in practice on the selection of analogies?

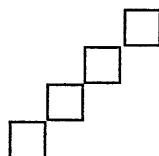
Metaphor and metonymy in the conceptualising process

I would like to start with an incident from the classroom.

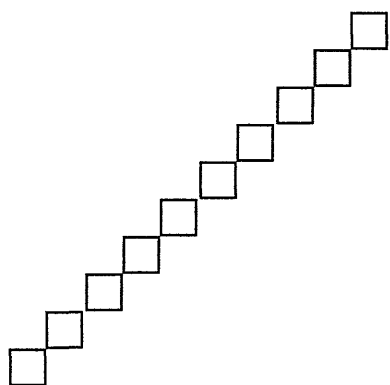
Maximum perimeter

I was observing Samantha, a mathematics teacher who was working on developing mathematical thinking with low attainers as part of the Improving Attainment in Mathematics Project. This lesson was tape-recorded and field

notes were made. Samantha had set year 7 students (11-12 years old) the task of exploring maximum and minimum perimeter with sets of squares from Ollerton's book (Ollerton, 2002, p5). They had started the task the previous lesson when, as a whole class, they discussed that the maximum perimeter with 4 squares could be obtained when the squares were presented like this



In this lesson, students were given 10 cut out squares. Bob and Shaun were working together. They had both made this configuration



I asked Bob why he was convinced this would give the maximum perimeter for 10 squares. He replied

“because with 4 tiles, this pattern gave maximum perimeter”

I asked Shaun why he was convinced this would give the maximum perimeter for 10 squares. He replied

“because you can count all the sides of the squares”

He then re-arranged 3 squares like this



and said

“when it is like this you can’t”

Analysis of the example

I thought these replies had a different quality. Both students had clearly been thinking about the mathematical problem and about their perceptions of the task. Both had formed a mental formulation of the configuration of squares that offered maximum perimeter. Both had thought about an underlying structure of when maximum perimeter is obtained. They had clearly, according to the definition in this thesis, conceptualised.

However, I think there was a difference: Bob had thought about it in a way that allowed him to replicate the pattern. He had analyzed his perceptions in such a way that he could mimic the pattern. His concept was an awareness

and identification of the appearance, of the impression of the object. He had identified an underlying structure of maximum perimeter as a pattern, as THIS pattern. Shaun, on the other hand, had thought about his perceptions in another way. He had identified an underlying structure of maximum perimeter as being the occurrence of the four sides of a square being countable. His concept offered a generalised notion that would allow him to generate more than one type of example. His concept gave him an idea of what upholds this pattern, what stands underneath, an under-standing.

I could categorize Bob's concept as pattern-following, without making connections between properties of a square, properties of perimeter and the concept of maximum to offer him an underlying reason as to *why* this pattern would give the maximum perimeter. His thinking seemed to consist of replicating what his senses (his eyes and hearing in this case) had perceived: seeing the pattern and hearing 'this gives the maximum perimeter'. I could define his concept as an example of a *perceptual concept*.

Shaun's answer I could categorize as showing an understanding of the underlying structure of the pattern by having made connections between properties of a square, properties of perimeter and the concept of maximum to offer him an underlying reason as to *why* this pattern would give the maximum perimeter. I could define his concept as an example of *conceptual concept*.

These differences in conceptualisation reminded me of similar discussions about differences between metaphor and metonymy.

Definitions and descriptions of metaphor and metonymy

Both metaphor and metonymy are tropes, which comes from the Greek word *tropos* which means a "turn", as in *heliotrope*, a flower which turns toward the sun. Originally a trope referred to any 'figurative' substitution in an expression's literal or normal form. Over time, such substitutions were categorized according to their characteristics and named metaphor, metonymy, etc. (Van Gorp *et al*, 1986, p425).

There are two major uses of metonymy and metaphor: in the world of rhetoric and in the world of cognitive linguistics. Rhetoric concerns the theory of language as it has been prevalent for nearly 2000 years up to the end of the 19th century. Rhetoric was the common grand thought between literature and language, that is, literature regarded itself as language. (Mandler, 1985, p41). Rhetoric sees language and literature as a set of technical methods that can be used effectively and persuasively to relate a theme or idea in an effort to convince (Van Gorp *et al*, 1986, p351).

The second approach is situated in the world of cognitive linguistics with its theories of representation and mental processes that generate human language (Mandler, 1985, p16). Hence, cognitive linguistics account for language in terms of current understanding of the human mind.

Metonymy

Examples of metonymy are: the kettle boils, Downing Street decided..., the pen is mightier than the sword.

The general definition of metonymy is ‘the use of a single characteristic to identify a more complex entity’. In rhetoric, metonymy is the substitution of one word for another with which it is associated. Metonymy works by contiguity rather than similarity. Typically, when someone uses metonymy, they don't wish to transfer qualities (as you do with metaphor); rather associations which may not be integral to the meaning are carried across. In cognitive linguistics, metonymy is one of the basic characteristics of cognition. It is common for people to take one well-understood or easy-to-perceive aspect of something and use that aspect to stand either for the thing as a whole or for some other aspect or part of it. This substitution is based on their association or proximity. (Van Gorp *et al*, 1986, p253).

Metaphor

Examples of metaphor are ‘burning ambition’, ‘the long arm of the law’, the

moon was a ghastly galleon tossed upon cloudy seas’.

Metaphor means literally “carrying meaning across from one domain to another” (Mason, 2002, p78). With a metaphor a comparison is made between two seemingly unrelated subjects. Typically, a first object is described as being a second object. In this way, attributes from the second object can be used to describe properties from the first object. (Van Gorp *et al*, 1986, pp248-250).

Metaphor is considered to be in another league of thinking altogether.

Metaphor is considered to be working with the intellect. Lakoff and Johnson argue for example that “abstract human thinking is metaphorical” (Lakoff and Johnson, 1999, p3),

and expanding on this:

“Without such metaphors [that allow thinking about similarity, that set up a similarity space], abstract thought is virtually impossible”

(Lakoff and Johnson, 1999, p59).

Metonymy and metaphor have been described in terms of dimensions, with metonymy operating on a horizontal level, metaphor on a vertical one by the linguist Jakobson. In the context of exploring disturbances that are related to

the linguistic disorder of aphasia he identified metaphor and metonymy, two poles of discourse that establish linguistic levels. He argued that these aphasic disturbances are also the defining characteristics of poetry and that they are founded on the idea that message (or text) construction is based on two operations which can operate simultaneously and which relate to metonymy and metaphor (Jakobson, 1980, pp93,94; Waugh, 1985, pp149-152; Lodge, 1980, pp 8-10). Metaphor and metonymy thus become forces organizing not only figures of speech but also language with their explanation located in the field of cognitive linguistics.

The horizontal operation concerns combinations where syntactic links and contexts are constructed. Relations are built through contiguity and juxtaposition implying time, cause and effect, and a chain of successive events. This is the metonymy operation. It is the dominant mode in prose and expresses itself in the chain of events, the plot, successive actions, a sequence of occurrences.

The vertical operation concerns selection where equivalent options are chosen. Relations are built through similarity, substitution, equivalence or contrast; through synonym and antonym implying not time but space and simultaneity. This is the metaphor operation. It is the dominant mode in poetry and expresses itself in rhyme, meter, symmetries, repetitions, motifs

(Jakobson, 1971, pp68-69; Jakobson, 1985, pp6, 28; Waugh, 1985, pp149-152).

Hence, because the substitution in metonymy is based on association or proximity, metonymy is ‘triggered’, and on the surface. It is the chain of links in ordinary conversation, where what one person says triggers associations in the other. Association and proximity work with emotion. Because there is no re-thinking required in trying to make sense of the new horizontal connections offered, metonymic conceptualising is much faster than metaphorical conceptualising. I will explore this further next.

‘The long arm of the law’ is a metaphor which I find easy to recognize because it is explicit in making apparently illogical connections, i.e. it is not logical for law to have bodily parts. For the same reason it can offer a sense of surprise and captivate the attention, as in for example

“The shining blade of the light *cuts through the dark curtains*”

(Vasalis, 1947, p14, my translation).

A metaphor allows me to compare objects which are different yet also similar. I could express it in terms of Gibson’s *affordances*: by comparing light with a shining blade, my attention is drawn to the cutting affordance of the light, which allows it to cut through the dark curtains and lighten the room.

Metaphor gives me a sense of creativity and lets me discover new properties, new knowledge, new affordances.

With metaphor, because of its vertical operation, active thinking is provoked. It invokes me to act for having to think about the relationships between vehicle and tenor. In Minsky language this means I am expanding my experience of relating the agents 'light' and 'blade' which were, previously, unrelated. In Vergnaud language it means I am expanding both my conceptual fields of 'light' and 'blade' while at the same time being aware of significant differences between the thinking required in these different conceptual fields.

'The kettle boils' is a metonymy and works differently to metaphor. It works on the basis of proximity, as present in Gestalt laws, i.e. kettle – heating – water - boils and thus works on activating and extending familiar experiences and relationships, triggering habits. Because of this it does not require consciousness, which makes metonymy harder to detect. Metonymy can thus re-inforce in me, without my being aware, what is already part of my norms. It makes me passive in that it does not require me to re-think my familiar norms nor to look for new connections. Whereas metaphor creates the relation between its objects e.g. 'light' and 'blade', metonymy presupposes that relation, e.g. 'kettle' and 'boiling'.

Because of its power and intent to illuminate similarities between objects, some authors go so far as to claim that metaphor has the power to express

‘essence’, unlike metonymy. The question remains whether connections based on similarities can be equated to ‘essence’, a sense of ‘truth’. In the next Chapter I will explore this relationship of similarities and ‘truth’ further. Metaphors do provoke thinking and looking for connections to find structural elements of the objects. They provoke thinking about what I perceive, about over-ruling the unconscious applications of Gestalt laws. Metaphors function as disturbances to stop me in my tracks of making sense and energise and empower me to re-think and re-examine my sense-making. In that sense, they offer me a sense of ‘essence’ of the objects, as they trigger me into examining otherwise unperceived elements of the objects.

Back to the example and why this is all relevant

Looking back at the example of Bob and Shaun, I can approach their conceptualisation differently and label the perceptual concept a conceptualisation based on metonymy and a conceptual concept based on metaphor: with the perceptual concept the similarity was triggered and was based on the physical characteristics of what was perceived (e.g. colour, shape, smell, or in this case, the lay-out). The conceptual concept at the other hand required re-thinking and looking at the characteristics of squares and combining these with characteristics of perimeter and the concept of maximum and identifying what elements are involved.

Why is this difference in conceptualising important to me? For four reasons:

- i. because I am trying to understand the process of how I make sense of things;
- ii. for pragmatic reasons since being aware of what is happening might offer me help in identifying my students' thinking allowing me to intervene in a more efficient way;
- iii. being aware of the differences in effect of using metonymy and metaphor might help me to develop mathematical tasks that include these tropes, taking into account the purpose of the task;
- iv. it helps me to notice and become aware of subtleties in energy flow in the process of making sense.

There might be other ways as well to achieve these purposes. In the world of visual art for example, conceptual artists try to evoke conceptual conceptualising as well. They concern themselves to present a mental formulation of the object and avoid offering a perceptual image of the object.

There is also Minimalism which is similar in many aspects but also incorporates a similar approach of 'essence' to the materials used in the work.

The questions I ask myself are: Is there similarity between Conceptual Art and Minimalism, metaphor and metonymy? If so, how is this similarity achieved?

With these questions in mind I embark on an explanation of aspects of conceptual art and minimalism relevant to the mathematics classroom.

Conceptual art

Conceptual Art is provocative as it tries to question the meaning of art itself.

As a result, it is difficult to find a definition or a single description of this

School of Art. But here is an attempt:

Conceptual art is not only based on an idea, which all art is to a certain extent, but the idea of a work actually matters more than its physical representation.

Conceptualism often relies on systems or patterns that are set in motion by the artist and allowed to generate work with little interference. A Conceptual

work may rely on a formula that dictates the end result even before the work is executed. It is based in the intellect rather than the eye. Conceptual Art is a

reaction to Abstract Expressionism, typified by Jackson Pollock, which is

sometimes considered the antithesis of Conceptual Art because it is created in the moment, with little planning or forethought in comparison with

Conceptual Art. Abstract Expressionism is about emotion and spontaneity,

whereas Conceptual Art is carefully planned and composed off the canvas and aims to be void of emotional interpretation of the artist.

Related to the school of Conceptual Art is Minimalism, with its resemblances to mathematical precision and austerity. I will explore Minimalism in more depth as I find its elements for the purpose of this enquiry easier to identify and analyse.

Minimalism

Minimalism originates from the work of a group of American artists during the 1960s. It was based on serial or whole geometrical abstraction. Leading figures are Flavin, Judd, Morris, LeWitt, Stella, Andre. In my account I will refer more extensively to the work of Judd, Andre, LeWitt and Morris and the writings of Meyer. Critic, art historian and author Meyer is a leading authority on Minimalism and American art of the 1960s. Judd is a painter and sculptor and one of the central figures associated with the development of Minimalist art. He also wrote reviews on Minimalist work. Andre is a sculptor and poet, LeWitt produces structures and reliefs, Morris is mainly a sculptor with a background in dance.

Describing Minimalist works of art

A Minimalist work of art is characterised by a minimum number of colours, values, shapes, lines and textures. Minimalist art seems to be constructed with mathematical precision, showing straight lines, grids, repetitions and symmetry. Focus is on simplicity in both content and form. No attempt is

made to represent or symbolize an object or experience, only to show structural characteristics of the object. A Minimalist work of art is therefore drained of any sign of personal expressivity of the artist. The aim of this is to allow the viewer to experience the work more intensely without the distractions of composition or theme. Another important aspect is the focus on wholeness, not detail, and on simplicity. Judd, a leading Minimalist artist described this as

“It isn’t necessary for a work to have a lot of things to look at, to compare, to analyse one by one, to contemplate. The thing as whole, its quality as a whole, is what is interesting. The main things are alone and are more intense, clear and powerful”

(Judd, 1965, p207)

Because of the avoidance of an object being interpreted or represented by something else, Minimalists were trying to remove the tropes, i.e. the metaphors, the metonymies. Additionally, because of the focus on wholeness, hierarchical perception is avoided by not using a part-by-part structure (Judd, 1965, p209). With the same aim, for the viewer to perceive only the simple material facts and not an ideal order (Meyer, 2002, p25), Judd uses symmetry in his work to get rid of any compositional effects (Glaser interviewing Judd, Stella and Morris, 1964, p197).

Thus in their presentation Minimalists try to overcome this unconscious tendency within the receptor or viewer of wanting to perceive according to Gestalt laws. Gestalt laws are also referred to in the world of design and graphics to understand structure and impact of the visual. In analysing design structure there is a concept of 'the visual hierarchy' which comes from subconscious decisions based mainly on Gestalt laws. Hereby any element of design is given a visual "weight" by the viewer: a relative power to pull and hold the viewer's attention.

Conceptual and Minimalist art try to over-rule the unconscious tendency to perceive in visual hierarchy by avoiding all emphasizing which would lead to stressing and consequently ignoring. Design works on manipulating this. Metaphors look for the same effect.

How does Minimalism achieve this over-ruling? What are the characteristics and their effect on the viewer?

Characteristics and their effect on the viewer

Two of the first things that strike me when viewing Minimalist art is an overwhelming sense of order, and purity. The order seems to channel my focus of attention and my energy flow towards the perfectly stripped down

objects. Because of this purity, the lack of an artist representation, I feel freed from having to interpret the work of art. As the Minimalist painter Stella says ‘What you see is what you get’ (Glaser interviewing Judd, Stella and Morris, 1964, p197). Because the work of art does not pretend to be something else, I experience a sense of truth and a sense of aesthetic. I perceive what *I see*, not what I am supposed to see. As a teacher of mathematics I find this very powerful: above all, I want my students to see mathematics for *itself by themselves*, not how I, the teacher, see and experience mathematics. Other characteristics of Minimalism that are linked to the above and that seems to have an effect on my perception are the focus on shapes and the emphasis on truth to real-world metals, bricks and junk.

One of the more extreme examples of this comes from Minimalist sculptor Andre who composed several works of art, such as *Lever* and *Equivalent I-VIII* consisting of firebricks, laid in a straight line, or in cuboids. Meyer described the effect this had:

‘We take bricks for granted; we see them as components of a larger entity, the wall we walk past everyday. But because Andre’s bricks are placed on the floor in front of us in a simple pile we are forced to view them as bricks: seeing them as bricks, we see them anew. We are asked to reflect on what a brick is,

where it is made, and how it is typically used. Because the brick is removed from practical use, it is estranged from itself, as the Russian formalists would say. It is resemanticized as art... In being revealed as itself it speaks to what it was in the world'

(Meyer, 2001, pp186-187)

Again, the characteristic of purity plays a major role in this. But it also reminds me of Gibson's idea that most objects give rise to more than one *affordance*: by seeing the bricks in this 'pure' form and out of its usual context and affordance of a building element, I can now perceive the brick's structural elements *as itself*, giving it affordances of a cuboid, with its symmetries, parallel lines, right angles etc. Personally and importantly, it gives me an affordance of aesthetic. It reminds me of situations in my classroom, with for example operation signs, or the equal sign. These tend to be part of sentences such as $3 + 4 = 7$, with the focus going to 'calculate'. Offering for example the equal sign in isolation, allows for a different kind of exploration, of the equal sign *as itself*. Similar then to Meyer's idea that 'The shape *is* the object', it's wholeness secured by the 'singleness of the shape' (Meyer, 2001, p230), the equal sign becomes the object, the focus of my attention. By offering it on its own, in its singleness, it makes it the whole of the exploration.

I find explaining these experiences in terms of *functionalities* easier to use for analysis. When the object brick is part of a wall, its *functionality* is that of one of many of the building bricks that make up the wall: a subset of the wall with its characteristics of being able to offer support, strength, its colour as part of the whole etc defining its *functionality*. In a more mathematical way I write this as $f(\text{brick}) = \text{element of the wall}$. When the brick is offered in the setting of Andre's works, its *functionality* changes because the context of the wall has been removed. Using Meyer's description of the effects this has, the brick's *functionality* is that of the characteristics of itself, for example its shape, colour, angles, robustness. In a more mathematical way I write this as $f(\text{brick}) = \text{brick}$, a kind of identity function. I conjectured earlier that the *functionality* of an object depends on the context in which it is placed. In Minimalism the context allows for the object to have an identity functionality. When in my classroom I want to focus on the equal sign as an identity functionality I can use techniques from Minimalism to try to achieve this.

Repetition and Serialism

Another characteristic of Minimalism is repetition. The school of Minimalism is also present in the world of classical music, with repetition easily identifiable in auditory form. In Minimalist music small phrases are being repeated, with slight variations and rearranged in different

permutations, again and again. By varying a small amount of musical information and repeating it the focus of attention is drawn to these elements, illuminating them and possible permutations explored. Such technique of repetition also comes back in the concept of Serialism, a recurring characteristic in Minimalism and Conceptualism, typified by Andy Warhol's paintings of Campbell's soup cans. Here, seemingly identical images are presented only varied in a small way, thus conveying different variations on an idea. LeWitt, Minimalist artist, described the rationale of Serialist artists in an illuminating way:

'Serial compositions are multi-part pieces with regulated changes. The differences between the parts are the subject of the composition. If some parts remain constant it is to punctuate the changes'

(LeWitt, 1966, p226)

Serialism and Musical Minimalism offer variation, alteration, reproduction and correction about which Jauss wrote 'variation and correction determine the scope, whereas alteration and reproduction determine the borders of a genre-structure (Jauss, 1982, p22) - scope meaning range, terms of reference (Elliott, 1997). Serialism and Musical Minimalism could seem to achieve both. Mathematics educators Marton and Booth (1997) explored the concept

of variation in mathematics lessons in the context of what students learn to discern in a lesson, with learning seen as learning to discern. They argued that general aspects of a particular situation that is to be experienced correspond to what they coined *dimensions-of-variation*. Learning to discern mathematical concepts and technical terms happens through experiences which can be described in terms of *dimensions-of-variation* and in terms of relationships between the different *dimensions-of-variations* (Marton and Booth, 1997, p108). In a few pages I will re-address these issues in the context of a classroom example.

Another element of minimalism: reader response

Another element in the philosophy of Minimalism involves aesthetic intent, which resonates with Reader Theory in literary analysis. To understand it fully, I will first address this theory.

Reader theory

Reader Theory offers a different approach on the process of making sense. It was developed in the realms of literary analysis from the 1960s and draws on phenomenological philosophy. The theory is not as such concerned with the procedural process of what happens between input and concept (referred to as output in Reader Theory) or which connections are made, but focuses instead on the difference between the input of the author in the form of a text and the

resulting concept with the reader. There are two linked trajectories in Reader Theory. The first one, often called 'Aesthetic of Reception' has Jauss as leading figure and originates from Germany. Its focus is on the result of the reading process in relation to the reader's consciousness. The second trajectory is called 'Reader response theory', largely developed in the United States and has Iser (German but working in the US) as leading figure. He approaches a text as a potential structure which is 'concretized' by the reader in a period of 'Unbestimmtheit' or 'Indeterminacy'. I will expand on these differences later.

In this section I will expand on the *basis* of the theory, which states that what happens in the process of making sense between input and output depends on the individual and on their past experiences. It is therefore not observable, at least not by an external observer, and very often not by yourself either. This implies that theories about what exactly happens in the process are conjectures that can not be observed. I see and make sense of the world in terms that have meaning for me. Jauss described the process involved beautifully:

"A literary work... does not present itself as something absolutely new in an informal vacuum. It awakes memories of that which was already read, brings the reader to a specific emotional attitude,

and with its beginning arouses expectations for the 'middle' and the 'end', which can be maintained intact or altered, re-orientated or even fulfilled ironically in the course of the reading”

(Jauss, 1982, p23)

Iser shares this view and describes how this first happens in the process of perception:

“During the process of perception, we always select specific items from the mass of data available to our senses – a selection governed by our expectations”.

(Iser, 1978, p94),

then applying this to a literary text:

“A literary text avails itself of a mechanism that regulates perception in general... in accordance with the particular expectations of the observer”

(Iser, 1978, p98)

What exactly happens in that period between input and output remains thus, inevitably, vague. Ingarden refers to this period as ‘Unbestimmtheit’ or

‘Indeterminacy’ and defines a text as a potential structure which is ‘supplemented’ by the reader (Ingarden, 1973, p251).

The difference between input and output is described by Roman Jakobson (1985) in terms of ‘langue’ (being the text and the input) and ‘parole’ (being the output received by the reader) with langue and parole never being the same – something that became apparent to me while working on this thesis (as described in Chapter 3) when I found that the parole of readers of my texts (or verbal expressions) was *very* different and I decided to work on developing my langue for it to become more clear. In doing so I intended to limit what happened in the process of ‘Unbestimmtheit’ of the readers.

Iser (1978) had a slightly different focus – instead of asking what the text means, he asks what the text does to the reader. He argues that the reader can not mine out an objective meaning hidden within the text because the meaning of a text cannot be a copy of the reader’s own world because of personal experiences. He thus approaches a text as a potential structure for meaning making: although reader and text assume similar conventions from reality, from life, texts leave great portions unexplained to the reader, which can be manifested as gaps in the narrative or in the text’s limited interpretation of the world. Iser refers to the reader as an *implied* reader as the text requires the reader’s participation in giving meaning to the text during the

reading process (Iser, 1978, pp19, 24, 38). As Iser says 'It is in the reader that the text comes to life' (Iser, 1978, p19).

Lacan (1977) builds on this theory and offers another insight. He bases his theory of meaning on a modified version of de Saussure's system of language based on a relation between signifier, being the sound image or the symbolic, and signified, being the concept or the real (de Saussure, 1974, pp xviii, 65-67). Lacan focuses on relations between signifiers alone and places this in the realm of psychoanalysis. Signifiers are the elements of the unconscious such as wishes and desires and all these signifiers form a 'signifying chain'.

According to Lacan (Lacan, 1977, p153, 154) there are no signifieds. As according to Lacanian psycho-analysis the unconscious is structured as a language, there are thus no signified in the unconscious and no signified can be brought to consciousness. Hence, signifiers can never represent something absolute as a signified. Consequently, the signifying chain is constantly in movement as it never stops because of this lack of signifieds, and one signifier leads to another one. Meaning therefore comes from the correlation between signifiers in so far that a signifier has meaning because of the discerned difference between the signifiers. Technically this happens as one signifier supplants the other metonymically, as

"For the signifier, by its very nature always anticipates meaning

by unfolding its dimension before it”

(Lacan, 1977, p154)

This sense of dimension corresponds with Jakobson's distinction between two poles of language, metaphor and metonymy and although this can give us a *sense* that meaning consists in language it is actually not the case as there is an absolute barrier between the signifier and the signified, or between the symbolic and the real.

Lacan's idea of never ending 'signifying chain' resembles my experience of writing this thesis: there are moments when I think "Ah, this is what it means, this is the explanation. So x is like this because of y". But then shortly after is followed by "But if x is like this because of y, why is y like that?" and the chain goes on and on. By using Lacan's theory this is because of the non-existence of signifieds.

Based on personal resonating experiences and on the premise that by continuing to live I automatically experience, hence providing indefinite experiences that can provide signifiers I do agree with Lacan's view that there are no signifieds in the long term. However, on a shorter time scale I would argue there are signifieds the moment I think "Ah, x is because of y". In that moment, y is the signified which then later becomes signifier when I think

“but what does y mean?”.

Lacan’s view of how meaning formation takes places in the ‘signifying chain’ from the correlation and differences between signifiers resonates with Marton and Booth’s view of learning as learning to discern (1997) and puts the concept of ‘learning’ and ‘giving meaning’ on the same platform. Which is important for me as a teacher, as my teaching should thus focus on offering students opportunity to give meaning to something.

I can also use Gibson’s language of *affordances* to describe moving along the ‘signifying chain’ of desires: the signifier ‘dry throat’ with the ‘thirst’ affordance leads to signifier ‘water’ with the ‘drinking’ affordance leads to signifier ‘wine’ with the ‘nice tasting’ affordance leads to the signifier ‘evening’ with the ‘dinner’ affordance. It seems an application of Gibson’s identification of affordances in reverse I mentioned earlier in this chapter when perceiving an object, or signifier in this case, triggers knowledge about its affordances.

In a more mathematical language this ‘signifying chain’ gives me a sense of a cyclic permutation of an *indefinite* set. Each signifier is a member of the set and each member or signifier is replaced by a successive one. The set is indefinite because there is no signified that ever halts the process, that

functions as the 'last' identifiable member and the number of signifiers is undeterminable as they originate from the unconscious.

I conjecture the correlation between the signifiers is described by their *affordances* or *functionalities*. Consequently, it is the *affordance* and *functionality* that give meaning to the experience. This conjecture is central to my understanding of why offering a connectivist curriculum is important: by offering tasks on a mathematical concept that allow connections to be explored and multiple representations to be used, the task can trigger the creation of complex meaning of the concept as the different connections show the different *affordances* or *functionalities* of the concept.

Back to minimalism and aesthetic intent

Minimalism relates to Reader Theory in two ways. Firstly, Minimalism seeks to remove any sign of personal interpretation by the artist, of any representation. The aim of Minimalism is to allow the viewer to experience the work more intensely without the distractions such as composition or theme. Hence, Minimalism could be considered to tie in with Reader Theory, by on the one hand limiting and on the other hand exploiting what happens in the period of 'Unbestimmtheit'.

Here I use limiting in the sense that I should not get distracted by non-

essentials; 'exploiting' in the sense that I will not be sucked in by emotions or connotations the artist associates with the object, whether emotionally or cognitively. It allows me to make up my own mind. LeWitt states this explicitly:

"The aim of the artist would not be to instruct the viewer but to give him information. Whether the viewer understands this information is incidental to the artist; one cannot foresee the understanding of all one's viewers".

(LeWitt, 1966, p226)

The second way Minimalism relates to Reader Theory is the explicitness of such aesthetic intent. Although different artists seem to have different intents, what they have in common is their careful consideration and explicitness of the role the viewer has to play. The sculptor Morris, for example, with a background in dance, built his earlier sculptures to bodily scale (Meyer, 2001, p51). Instead of expecting his viewers to stand apart from the work, he included them as active participants. Morris' work was to be experienced through physical participation. Judd's work, on the contrary, was mainly something to look at, based on a 'pictorial model' which Meyer describes as 'the Specific Object that presents a static, articulated shape to a viewer's gaze' (Meyer, 2001, p51).

Conclusion

Because metaphors are instrumental in making connections between objects, thereby illuminating structural elements, metaphors deliver a sense of essence. A similar sense of essence is experienced with Minimalism and Conceptual Art because of its elements of purity and lack of distraction. At the same time, the latter reject all reference to tropes or symbolism to represent the object and present it as it is, stripped of any artistic interpretation and affect. The most extreme case of emphasizing being allowed in conceptual art is Serialism which works on using slight variations on a repetitive theme as Warhol did with his work on Marilyn Monroe with similarities in structure to be found in Minimalist music by composers such as Reich. My first instinct would be to claim that metaphor and conceptual art/minimalism are paradoxes. However, at the same time each claims to offer a way to find 'essence' because they provoke thinking and looking for connections to reveal structural elements of the objects. This articulation begs the question of what 'essence' is, which I will not explore here. It is sufficient for my purposes here that it be taken to refer to 'the sense made'. Both metaphor and conceptual art want to provoke thinking about what is perceived, over-ruling unconscious applications of Gestalt laws. What is different is their aesthetic intent: with metaphor the connection-making that is

being provoked is explicit and determined by the chosen trope and the focus of attention is drawn to that connection. With Minimalism and Conceptual Art the focus is on presenting the 'essence' and allowing the receiver to make up their own mind, avoiding all connotations an artist might have with the object. But what excites me most is that metaphor, Conceptual Art and Minimalism have the power to energise me to make me question the unconscious assumptions I have made when perceptualising and to explore possible other connections. Instead of being carried along or dragged along the river of energy their characteristic elements force me to stop and explore other possibilities, other crevices, side-rivers and flows. This in combination with my conjecture that meaning is given by the affordances or functionalities of the signifiers of an experience gives me powerful tools to analyse my teaching practice and support me in developing tasks I offer students.

In Chapter 2, I explained how descriptions and incidents from my classroom and from my ordinary life are offered in this thesis as exemplification of identified phenomena and how they are developed and inserted with the aim of incorporating a metaphorical experience that would allow you, the reader, to be drawn into the structural and accumulated aspects of the arguments of this thesis. An example of this is the story of Bob and Shaun and the square task. Both the task and Bob and Shaun's response I consider generic, illustrating identified underlying phenomena. To place what I have learned

from my explorations in the realms of literature and art into mathematics education I will now re-visit the example of Bob and Shaun.

Bob's answer I categorized as a perceptual concept, resembling effects resulting from metonymy. Shaun's answer I categorized as a conceptual concept, resembling response to metaphor, which in turn seem similar to those arising from Conceptual Art and Minimalism. It might be that Bob's perceptual concept is part of the scaffolding needed to arrive at the conceptual concept, but I cannot know that.

What interests me greatly is what it was in the task design that mobilised this energy for conceptual conceptualisation and allowed connections to be discovered or to emerge in consciousness. The task was presented in a kind of Minimalist way, without a story, without a 'real life' context, with only 'essential' elements given. Indeed, Ollerton, author of the task, is explicit about this and writes

“Mathematics is a beautiful, exciting and mind-bending discipline and I have purposefully stayed away from using, so-called, real-life contexts within which to frame mathematics” and “The context I offer is problem solving; through engagement with such problems I suggest the beauty and the intrigue of mathematics

arises”

(Ollerton, 2002, p iii)

The task included elements akin to Serialism: *variation* on a small element or idea, i.e. changing the numbers of squares used while going for the same aim of finding maximum perimeter, *alteration* by having the choice to change the pattern, *reproduction* by following the thinking with different numbers of squares and *correction* by being able to check whether the perimeter was the biggest possible and by being able to correct the pattern. These indeed are the elements that Jauss argued would allow for determination of the scope and the borders of (in the literary case) a genre-structure (Jauss, 1982, p22). The task design disturbed the students from unconsciously following their perceptual train of thought and focused the attention on exploring other possible connections.

I will now explore significant aspects and elements of the perceptualising and conceptualising process and their roles, first addressing assumptions & expectations, followed by disturbances.

Assumptions and expectations

When exploring perceptualising and conceptualising earlier in this chapter, two recurring elements were *assumptions* and *expectations*, as mentioned

earlier in this chapter. In the process of perceptualising a percept is unconsciously impressed on our mind. According to Gestalt laws I, as a human, have unconsciously a tendency to perceive similarity and, because of the law of closure, a tendency to fill in gaps, to assume missing elements are present. Minsky calls these 'default assumptions' because 'missing information will be filled in by default' (Minsky, 1988, p245). This is part of his theory of 'Frames of Mind' in which actions (procedures) are initiated when required inputs are all evaluated, inducing default values for incomplete information. Expectations were also mentioned in the constructivist view on perceptualising with Helmholtz agreeing that meaning is added to sensory information but in the form of unconscious inference and that as a result of our expectations we 'see' things which might actually be different. Both refer to making assumptions and expectations unconsciously and because of the tendency to perceive similarity, incorrect assumptions can be made, especially if the input is something new or unusual. Ittelson (1968) and Minsky argued similarly but in very different domains. Ittelson's interests were in, amongst others, environmental psychology which concerns the relationship between human behaviour and the human physical environment while Minsky placed his reasoning in the domain of Artificial Intelligence. Ittelson's book 'The Ames Demonstrations in Perception' (1968) includes writings of Ames' studies of the psychology of visual perception. These studies include conjectures of how perceptual hypotheses are formed on past experiences. If

a visual display *appears* familiar but is actually novel, subjective contributions to the objective perception are made using existing perceptual hypotheses. These can thus be inaccurate (Ittelson, 1968, pp23,29,32,33,40,41). Minsky phrased his similar conjecture as ‘Frames are drawn from past experiences and rarely fit new situations perfectly’ (Minsky, 1988, p245).

I have noticed from personal experience that my assumptions do not always ‘fit’. The incident I will describe next and which was recorded in my journal, took place while visiting friends in France. Persons involved are Rolf, my husband; Berend, my son; Joe, Berend’s friend and Jacqueline, Joe’s mother.

Rolf’s time keeping

We wanted to take Berend and Joe canoeing the next day and had to arrange with Joe’s mother what time we would pick up Joe. Because all kinds of other activities and arrangements had to be taken into account this was no simple matter. Rolf discussed it in detail with Jacqueline, taking into consideration what was to happen before and after. It was an involved, pleasant and lively discussion. Although I could hear them, I did not interfere and relaxed around the swimming pool. The following day, Rolf could not remember what time had been agreed. We laughed and talked about it. In the course of the following

days, we had to make similar arrangements anew. Again, this involved lively and pleasant discussions between Rolf and Jacqueline. Again, the day after, Rolf could not remember the agreed time. This happened three times.

I was surprised by what had happened. I could understand and sympathize with Rolf forgetting it once. But three times in a row? On every occasion I had been disturbed that my expectation that Rolf would remember was not met. It was only after the third time that I started considering my assumptions might be wrong. I had expected Rolf would remember because I assumed that

- he had been intensely involved in making the appointments, assuming in turn that this would create a lasting impression;
- he had used logic and reasoning to come to the times agreed, assuming in turn he would be able to reconstruct in case he forgot;
- he did not want to disappoint the children, assuming in turn that the children would be disappointed if we were late;
- he would not like to hang around which might happen if we were not there on the time agreed, assuming in turn that this would happen.

In my process of perceptualising the 'input' I was unconsciously looking for similar situations in my past experiences and, because of the law of closure, I

filled in missing gaps. I made 'default assumptions'. Although the input looked familiar to me as I have had discussions with mums to arrange dates and times for my son to play with their children, it had some very new elements, i.e. this time it was Rolf, not me, who made the arrangements. What happened was as Ittelson says: the visual (and in this case also partly auditory) display appeared familiar while it was actually novel. As a result my perceptual hypotheses formed were in effect inaccurate. My assumptions had been based on my past experiences of arranging meetings with parents and my reference frame was thus indeed as Minsky described 'drawn from past experiences' but not fitting the 'new situation perfectly' (Minsky, 1988, p245).

My reflection kept returning to a single question: 'How is it that I continued using a 'perceptual hypothesis' or 'frames' from past experiences which did not fit this new situation perfectly?' Indeed fit it far from perfectly as it turned out I had it 'wrong' three times.

Ricoeur is a philosopher-critic with an interest in the notion of interpretation. He argues that the impulse to understand, to make sense, is always motivated by the need to make the world over into terms which are meaningful to the individual self (Ricoeur, 1981, pp1084-1090). This implies that to understand, I will make sense in terms of what holds meaning for me, which

is logged as past experiences. Making assumptions, whether 'correct' or 'incorrect' is thus not a question of choice, but of necessity. In this case I could not help making the assumptions I had made, I had no choice, because this is simply the way I make sense.

Apart from important consequences that the assigned assumptions have, Minsky considers the roles these assignments of assumptions have to play as 'of huge significance, because they help us represent our previous experience. We use them for reasoning, recognizing, generalizing, predicting what may happen next and knowing what we ought to try when expectations aren't met' (Minsky, 1988, p245). In this process, to find a generalized and recognisable percept we can 'construct unframes by formulating descriptions that suppress details we regard as insignificant' (Minsky, 1988, p203). In other words, my percept of an input will have simply ignored details considered insignificant or 'not fitting' my frame or assumptions.

In my impulse to understand, I had made what was happening into terms that were meaningful to me from past experiences of making arrangements with mothers of other children. Also, I had not been personally involved in the discussions between Jacqueline and Rolf - I was relaxing by the pool.

Although I could hear, I was not actively listening. In the process of making sense I had generalised by describing for myself what was happening using

default assumptions and without doubt suppressing some elements which I considered insignificant. These assumptions in turn led me to certain expectations, i.e. that Rolf would remember.

Looking back at Reader Theory, Iser talked about an 'implied reader' in the relationship text-reader meaning that a text implicitly implicates a reader's participation because it is the reader who synthesizes the events for meaning. Applying this theory to the example of 'Rolf's timekeeping' offers an extra dimension and reiterates the analysis I have made so far: Rolf and Jacqueline's lively discussion was the 'text', with me the receiver, the reader. We all assume (I think) largely similar conventions from reality. But the discussion I heard left great portions unexplained to me, which could be for example because I did not listen carefully, I did not see the body language, and more fundamentally, because I do not know what goes on in other peoples' head, nor what assumptions and expectations they have. Also, as stated earlier, in the process of making sense of the text I had generalised using default assumptions and without doubt suppressing some elements which I considered insignificant or which did not 'fit' I had not taken into account that I was the 'reader' with the 'text' being the interaction between Rolf and Jacqueline and that this role comes with the restriction of not being able to mine out an objective meaning hidden within the discussion.

Something else disturbed me about the incident: on each occasion that Rolf had forgotten, I talked to him. I asked him questions to clarify some things, but still, I did not realise I was giving an ‘incorrect’ meaning to what was happening. Why did the questions I asked not alert me to this? Gattegno argues that both listening and asking a good question require surrender, which means holding your pre-conceptions, your assumptions:

‘The spirit in surrender resides in the awareness that the dialogue involves an entity, a reality, which is other than ourselves and needs to be taken in and into account for what it is’

(Gattegno, 1985, p12).

Hence, because I could not hold my assumptions when asking Rolf questions, indeed I was not even aware I had made assumptions, I could not ask a good question that could have allowed me to give a different meaning to the incident, to the ‘text’.

Not being able to hold my assumptions and asking a good question also happens in the classroom, as the following example shows which was recorded in my journal.

Jill and exam stress

Jill was a year 10 student. It was after the end-of-year examination. I was to have a one-to-one session with her in which we were going to discuss her exam. On the exam paper, Jill had written with certain questions “I do not think we ever did this” and “I cannot remember anything of this”. I assumed she was suffering from exam stress. I decided that in this one-to-one I would talk to her about exam stress, symptoms, and techniques to help overcome and alleviate it. I started explaining my thoughts to Jill and she butted in “I do not suffer from exam stress. I am never nervous during an exam. I do not panic.” Although I could hear her say this, I could not act upon this information. I found I could not stop myself from explaining exam stress.

What happened was that in the process of making sense of Jill’s comments on her examination paper, in the impulse to understand and with Ricoeur’s ideas in mind (see earlier in this Chapter), I wanted to make the world over in terms which had meaning to me, looking at past experiences in doing so. I placed the *functionality* of examination stress in my personal experiencing world. The past experience of suffering from exam stress showed similarity, even though this ‘perceptual hypothesis’ or ‘frames’ did not fit this new situation perfectly. By formulating descriptions and generalisations based on these, I considered certain details insignificant and suppressed these (Minsky, 1988,

p203). Other missing elements I assumed by default. In this case I was aware I had made assumptions, but it did not cross my mind these could be wrong. I could not hold my assumptions and was thus not able to ask a 'good' question that would let me find out what actually was the matter with Jill.

Boole, mathematics educator, describes such similar experiences as *teacher's lust* (Boole, 1987, p11), where teachers are so caught up in what they want to say that their sensitivity to others is temporarily blunted. Learners responses to tasks could be analysed similarly: they often 'jump' at the first interpretation, in the process making default assumptions. They seem unable to 'think' about what they are doing even when urged by the teacher to do so by prompts such as 'check your work', 'read the question carefully', 'draw a diagram'. In the heat of the moment, learners forget – as happened to Rolf in the previous example.

From assumptions to disturbances

To become aware that I had made 'wrong' assumptions I needed to be disturbed by Jill saying that she did not suffer from exam stress, or in Rolf's case by my expectations not being met three times in a row. Another issue is that becoming aware of my assumptions does not mean I can act upon this new information and hold my assumptions. It seems that once I have spotted

a 'fitting past experience', a well of energy is created and I am taken into this unstoppable river flow. My 'teacher's lust' becomes prominent. I will explore why this is in the next chapter.

Disturbances interrupt flow. They make me question my assumptions and thus the validity of my making sense. When I am 'stopped in my tracks' I am made to re-think, re-consider. That is not a bad thing and something I consider very important in the act of learning. Minsky elaborates on this interestingly in his chapter 'Learning from failure':

"Learning has at least two sides. Some parts of our minds learn from success – by remembering when methods work. But other portions of our minds learn mainly when we make mistakes, by remembering the circumstances in which various models failed to work. ... Thus learning from success tends to aim and focus how we think, while learning from failure also leads to more productive thoughts, but in a less directed way.... Confining ourselves to "positive" learning experiences alone leads to relatively small improvements in what we can already do. Probably, there is no way to avoid at least a certain degree of discomfort when we make substantial changes in how we think".

(Minsky, 1988, p96).

Learning from failure allows us to re-think, to re-consider, allows us to search for other possible connections, rather the way metaphor does. If I want my students to experience the effect of 'learn from failure', I may have to disturb their thinking.

I have had many discussions with colleagues at school who argue that letting learners experience failure is detrimental for their self-esteem and for their learning. They are of the opinion that students should be sheltered from failure and in order to achieve this adapt their questioning style to a 'safe' mode where students can not give a wrong answer. I find Dewey's view of 'experience' interesting and pertinent in this context. Dewey (1859-1952) was a pragmatic philosopher and educator and advocate of child-centred schools. In his book 'Democracy and Education' (1967) he argues that the nature of experience exists of two elements: an active part, where experience is *trying* and a passive part, where experience is *undergoing*. The importance of these parts he explains as follows:

"When we experience something we act upon it, we do something with it; then we suffer or undergo the consequences. We do something to the thing and then it does something to us in return: such is the peculiar combination...Experience as trying [the first

element] involves change, but change is meaningless transition unless it is consciously connected with the return wave of consequences which flow from it. When an activity is continued into the undergoing of consequences, when the change made by action is reflected back into a change made in us, the mere flux is loaded with significance. We learn something.”

(Dewey, 1967, p139)

Dewey uses the example of burning your finger as a consequence of sticking it in a flame and states “The sticking of the finger into flame *means* a burn” (Dewey, 1967, p140). Hence, the experience is given meaning directly by its consequence. The experience is seen in function of its consequence. When students are sheltered from the consequences of their experiences, they will not learn, they will not be able to give meaning to their experience.

Interestingly, in the quote, Dewey use vocabulary reminiscent of my River of Energy: ‘flow from’, ‘return wave of consequences’. When I experience failure, my thinking frame collapses, my energy flow is blocked, it hits a wall (or cliffs). It signals the end of the first element of experience. The consequence of failure can feel as a return wave, not necessarily to drown me, but as a energy boost retracing where I came from.

What are disturbances and how and why do they work? I will explore this

next.

Disturbances

Why do I need disturbances?

The notion of disturbances has been mentioned in different contexts in this chapter.

I need to be disturbed to become aware that I have made ‘wrong’ assumptions in the conceptualising process. In the example of ‘Jill and exam stress’ it happened by Jill stating she did not suffer from exam stress; in ‘Rolf’s time keeping’ the disturbance came in the shape of my expectations not being met three times. Although there was a difference in being aware of making assumptions - in Jill’s case I was, with Rolf I was not – in either case until the moment of disturbance I was in no doubt about my assumptions, my sense of the situation.

I needed to be disturbed to push me to re-assess my perceptualising process which is informed unconsciously by Gestalt laws. These laws imply making default assumptions, which are not always ‘correct’.

I also needed to be disturbed to see new connections, which happen in both the perceptualising process through making default assumptions, and in the conceptualising process, when I had to overcome selecting similarities based

on association and proximity, as in metonymy or when there was a purposeful design to let me make certain connections between objects, as in metaphor.

I found I also needed to be disturbed in order to learn. One way is learning from failure which *makes* me look for other possible connections. Another way is by task design that harnesses or provokes a similar effect. ‘Maximum perimeter’ is an example of such a task as it disturbed Bob and Shaun from unconsciously following their perceptual train of thought and focused their attention on exploring other possible connections. Bell, a mathematics educator, worked at the Shell Centre at the University of Nottingham, where he prepared teaching materials using cognitive dissonance as a source for learning. Bell reported on these developments and their rationale in a series of articles in *Mathematics Teaching*. He wrote:

“... a short start activity ... would lead to the exposure of such misconceptions as are present in the pupils’ schemes and ideas. So it could be said that we deliberately gave them questions which at least some pupils would get wrong; and without forewarning them of possible hazards. The principle was that if there is an underlying misconception, then it’s ‘better out than in’; it needs to be seen and subjected to critical peer group discussion.... We saw the ‘conflict-discussion’ as the main learning experience, and the

written-work as introductory, giving the opportunity for opening up the situation and allowing some mistakes to be made which led to conflicts and hence discussion.”

(Bell, 1986, pp27,28)

Hence, cognitive dissonance causes disturbances which aid learning. It forces me to look for new connections, for alternative functionalities and affordances. Tasks that harness or provoke similar effects can be designed as shown by Bell and exemplified by the ‘Maximum Perimeter’ task (Ollerton, 2002).

What do disturbances do?

I conjecture that, in general, disturbances stop my train of thought. They provoke a re-evaluation of current parameters being used by frames on actions being executed (in the language of Minsky). They make me re-think, re-consider what my assumptions are, make me re-assess the validity of my sense-making and let me see possible other connections. Because it stops me in the flow of my thinking process, it pushes me, energises me, into becoming aware of the act of making sense. Disturbances thus play a vital role in the process of making sense, in giving meaning. I will discuss literature supporting this conjecture next.

Minsky argues that disturbances mainly originate from failing systems that trigger consciousness which in turn lead to confusion on which one acts by reflecting. He writes:

“It’s mainly when our systems fail that consciousness becomes engaged. When we recognize that we are confused, we begin to reflect on how our mind solves problems and engages the little we know about our strategies of thought”

(Minsky, 1988, p69).

Dewey elaborates by describing what happens in such a state of reflective thinking:

“reflective thinking, in distinction to other operations to which we apply the name of thought, involves (1) a state of doubt, hesitation, mental difficulty, in which thinking originates, and (2) an act of searching, hunting, enquiring, to find material that will resolve the doubt, settle and dispose of the complexity”

(Dewey, 1933, p12).

Festinger (1919-1989), a social psychologist with an interest in human learning considers cognitive dissonance as a *fundamental* experience in the

construction, negotiation and reconstruction of meaning and learning.

Festinger not only sees dissonance “as a motivating factor in its own right” (Festinger, 1957, p3) but also as a source of energy to capture attention and initiate enquiry. The energy comes from the tendency within a person to actively reduce the dissonance and avoid situations and information which could increase the dissonance (Festinger, 1957, p3). Gattegno also mentions dissonance as a mobiliser of energy. He places this in the context of ‘what is a question’ arguing that a question becomes a problem for which a solution is sought if it creates a tension in us. We are thus trying to dis-solve the tension (Gattegno, 1984, p5) for which energy is mobilised. The source of this energy comes from our sense of truth “which keeps in contact with our sense that we are right or wrong, or good or harmful. It is it which sustains our will...It is it which moves us in changing something...” (Gattegno, 1984, p10)

Minsky also explains how disturbances come to have an energizing effect. He argues that it is the conscious confusion that can come from being disturbed ‘that stimulates us to apply our intellect to altering or repairing the defective process’ (Minsky, 1988, p69). I do not disagree with this as such, but I wonder why this is. I suggest that underneath the energy influx from Minsky’s conscious confusion, disturbances also kick-start another form of

energy release, coming from the unconscious world of perceptualising. As the result of Gestalt laws, I experience an inert wish for perceiving stable input. My percept, and concept in turn, is balanced as a result. Disturbances un-balance me. But Gestalt laws require balance and hence will push me into finding a new connection that will offer this balance. Finding a new connection implies triggering a shift in attention, being it finding a completely new focus of attention or re-assessing and adjusting the existing focus of attention anew.

Hence, the energy I experience from disturbances would come from the wish for balance resulting from Gestalt laws.

Illustrative of these effects of disturbance is the report of Watson *et al* (2003) on how participating teachers of the Improving Attainment in Mathematics Project chose to react to incorrect answers of their students and to the disturbance incorrect answers cause. An example offered describes a student writing an incorrect answer on the board and the teacher reacting by saying “We are going to leave this on the board as, even though it is wrong, it might give you some ideas about what to do” (Watson *et al*, 2003, p21). By the teacher’s utterance, students become conscious that the answer is incorrect. If they agreed with the answer, they are now aware they should doubt their thinking which becomes unbalanced. The teacher explicitly directed students’

attention to the answer and its incorrectness with the aim to cause a disturbance in the students' thinking. The disturbance initiates enquiry and creates a tension within the students. They want to dis-solve this tension by looking for an answer.

It leads me to the question: what is focus of attention about?

Focus of attention

Focus of attention plays an important role in the process of making sense as it seems that similarity detected in past experience triggered is determined by my focus of attention at that moment.

But what is focus of attention in the context of making sense? My first port of call was the dictionary where 'focus' is described as (1) point at which rays etc meet after reflection or refraction or from which rays etc appear to proceed; (2) point at which object must be situated to give clearly defined image; (3) state of clear definition. 'Attention' is described as: act or faculty of applying one's mind, and 'apply' as: make use of (Elliott, 1997).

Putting these definitions together, I could describe 'my focus of attention' as:
(1) I am applying my mind to the point at which the object must be situated to give a clearly defined image; (2) I am applying my mind to where I get a clear

definition of the object; (3) I am applying my mind to the point at which rays meet after reflection or refraction; (4) I am applying my mind to the point from which rays appear to proceed.

Although (3) and (4) refer to optical sciences I could consider these definitions figuratively or metaphorically. The second description reminds me how the Gita offers eight reasons for obstruction of perception (Sinha, 1987, p31): something is too far away, something is too close, a sense organ is injured, non-steadiness of mind, something is exceedingly minute or subtle, some intrusion between an organ and the object to be perceived, masking (e.g. when one cannot see the planets because of the brightness of the sun), confusion with what is similar.

Hence, if something obstructs me from seeing 'clearly' a clearly defined image, I will not be able to perceive what is available to perceive. Referring back to the definitions of focus of attention, I could describe focus of attention as 'I am applying my mind to where I get a clear definition of the object in order to perceive it'. This raises two interesting questions: who is the 'I' in the definition? And, can I have more than one focus of attention at the same moment in time? The first question will be central to my explorations in Chapter 5. Regarding the latter question: I can imagine myself thinking of a few things at the same time, although it would require me to 'flick' from one to the other. I cannot imagine though, being able to hold on to unlimited foci

of attention at the same time. This seems obvious, but its implications on energy dynamics are interesting. It implies that whatever I focus on, that object will be clearer but other objects and elements will necessarily be vague and in the background. All the attention is directed towards the object of attention, and the energy required to feed the attention flows towards the object, as if the object functions as a mediator to permit flow in me.

Switching my focus of attention means thus not only getting an interest in another focus and letting the prevailing one go, but also stopping and redirecting my energy flow.

This conjecture has significant consequences for teaching and learning, for example in word problems. The following incident, which was recorded in my journal, involved one of my friends, Anna, a social scientist. I presented her with the following word problem:

Jane and Jack are running a race. Jane's average speed is 7 km per hour; Jack's is 8.5 km per hour. Jane is given a head start of 50 metres from the start line. Who will be furthest from the start line after running for 2 minutes?

When Anna started talking, she asked why the girl was given a head-start and why it was the girl that was the slower runner. The mathematical aspect of

the problem did not become her focus of attention until I directed her to it. She told me she felt resentful about that, because according to the meaning she had attached to the problem, the problem was invalid and calculations thus futile.

Anna had linked the word problem to her past experiences as in Iser's theory of the implied reader. She had 'scanned' the problem for elements that were relevant to her and her focus settled on the social aspect of gender inequality. Her mind was subsequently applied to that focus and analysed the situation against her previous experiences. All her energy flowed into giving meaning to the text based on that focus of attention. She could not attend to the mathematics at the same time and because of the meaning she had attached to the problem she was reluctant to do so later when prompted.

The energy that was needed to solve the mathematical aspect of the problem had been directed away to social aspects because Anna focused her attention on a different element of the text.

This incident is an illustration of a general phenomenon that is discussed next.

What is the relevance to the mathematics classroom?

The question that I pose myself now is: are my expectations as a mathematics teacher of my students that they will mine out an ‘objective’ meaning of the exercises or my exposition? And do I herewith automatically define ‘objective meaning’ as ‘my meaning’ without making this definition and expectations clear to my students? If so, this implies that I assume my students and I will have the same focus of attention. Even if this is the case, then, according to reader-response theory, I will not be able to observe this happening. What I can do, however, is put constraints in a task to limit what can happen in the period of ‘Unbestimmtheit’, to disturb the expected flow of student energies.

When I want my students’ focus of attention to be firmly on one or a few mathematical objects and on nothing else, I can apply Iser’s theory of the ‘implied’ reader and limit what happens in this virtual space between input and concept. I can do this by using constraints in a task with the same aims as minimalism: to allow the learner to experience the mathematics more intensely without distracting features. Hence, the roles of these constraints are to focus the attention on what I consider to be the ‘objective meaning’, to help avoiding being distracted or to avoid escapism to more comfortable and familiar things (such as colouring in). Such constraints are present in Ollerton’s task and in the examples of Alexandra’s and Camilla’s classroom in the previous chapter. The constraints are there to pin the focus of attention

on one or a few objects. Both Ollerton's task and Alexandra's multiplication task offer easily identifiable constraints: Ollerton constrains the activity by limiting objects to squares and allowing only variations in the number of squares used. Hence there is no distraction in the form of other shapes for example.

Alexandra was very explicit in the procedural aspects of the task, thereby not allowing the distraction of doing anything else at all. A task with less identifiable constraints that would limit what students think in the period of 'Unbestimmtheit' is Camille's example of her journey into Wales. By using a story with elements of surprise, an identifiable character, recognisable feelings and emotions, Camille drew her students into experiencing the story with her. They were being caught up in the story and once this happened distractions could be limited to details presented and discussed, using, probably unintentionally, characteristics of metonymy and metaphor. The story, sequential in nature and time, used recognisable emotions students could associate with. The story was 'easy to follow' with a sense of proximity. There was little or no thinking required and the story set a fast pace, showing all elements of metonymy. Once the students were drawn into this flow, Camille focussed attention on certain mathematical aspects in the story by making small variations, thus displaying their structure and properties, as a metaphor.

The question is whether emotions, as they were provoked in this task, can feed consciousness needed for making new connections. Greenfield, a neuroscientist, argues from a neurological point, that this is possible, stating ‘emotions are the most basic form of consciousness and, in turn, may be related to small assemblies of neurons in the brain’ (Greenfield, 2000, p178). However, she also points out that ‘strong emotional states are characterized by an awareness of only the present and an absence of thought or logic’ (Greenfield, 2000, p178). Hence a *strong* emotional state may not be what I would wish for in my classroom as it impairs logic and makes changing focus of attention difficult, which encapsulates my diagram and the explorations around it in the previous chapter. This is what Mason refers to as ‘harnessing emotions’ in order both to educate awareness and to train behaviour (Mason, 2002, pp96,141).

There are also times, however, when I want my students to vary their foci of attention, for example when I want them to explore connections between mathematical concepts. This is what is required if I want my students to conceptualise conceptually as opposed to perceptually: I will have to disturb the students from focussing on a single object. How can I provoke such disturbances that will promote learning in my students?

What disturbances have in common is that they bring about a change in focus of attention. Bollas, a psychotherapist, states that such change can be achieved from selecting an object that is different from the present focus of attention (Bollas, 1997, pp.17, 21, 22, 24, 25). To avoid confusion with ‘object’ as used before in the sense of ‘input’, I will refer to Bollas’ object as *b-object*. An example where I used a *b-object* to change my focus of attention was the story of Macy’s- behaviour-I-did-not-like in the previous chapter. My focus of attention was on ‘Macy behaves like this and it does annoy me’ and I experienced that as I stayed in that thinking frame I noticed more and more things I did not like. But I found a *b-object* in the form of the contemplation ‘Macy’s behaviour is rather interesting’. The *b-object* allowed me to see the experience in another functionality. It helped me change my focus of attention and I now looked at her gestures, posture and interaction with other students with the new context in mind.

Elements of structure of causing disturbances

I will now look at the elements of the structure of causing disturbances that are used in stage-design in the theatre, in metaphor, in Minimalism and Serialism and in asking ‘good’ questions. Then I will use these characteristics to analyse some tasks that I have used or seen used in the classroom that seemed to have triggered conceptual conceptualising.

Stage-design in the theatre

I have recently seen some interesting plays in the theatre where it was not so much the text or dialogues that caused a disturbance in me as the stage design. For example, I experienced such stage-design when watching a play of Proust by the Rotterdams Theater. Coincidentally and helpfully to me, they had also published a 'workbook' of the play in which the process and the rationale of their choices is described and to which I will refer.

In this staging of the play photographic slides are projected on white screens. Sometimes they displayed pictures, sometimes words, sometimes just colours. The pictures were not an illustration of the text. For example if in the dialogue they were talking about red flowers, the colour green might be used. The fact that pictures and text differed, that I could not transpose one onto the other, disturbed me. The result was interesting because I was strongly aware of the difference between text and image. I also noticed that I had a heightened awareness of the dialogues. It made me think about the significance of the text, of the choice of the colour red in the story. Words were never projected during the dialogues, but always beforehand or afterwards. They did not repeat the concepts of the dialogues, but referred to notions of percepts, such as identified sounds, tastes, felt experiences, and smell and seemed to be chosen to reflect the feeling that they provoked in the text (Proust, 2003, p104, 114). Why displaying percepts? Marc Warning, the

stage-director, explains his rationale: ‘Reading Proust is a physical and mental experience. If you want to transpose this experience to the public, you have to precipitate with the senses’ (Proust, 2003, p210). The aim of using photographic slides in such a way was to address the imagination of the public every time in a different way (Proust, 2003, p114), with the intention of showing the inner world of Proust (Proust, 2003, p126).

The Rotterdams Theater creates disturbances in their stage-design to make me, the viewer, re-think what it is I think I am seeing. It sharpens awareness through disturbance, presumably in order to increase my understanding of the play and maybe also of myself. Warning is explicit about this. He says

“it is not only about the atmosphere [of the play] but also about questions such as ‘How do I, the viewer, look at this information? How do I, the viewer, absorb this information? I want to make the people think about their viewing behaviour”

(Proust, 2003, p206-210, my translation).

The photographic slides offered me an object that triggered me to re-focus my attention. They offered me an image with on the one hand a metaphorical aspect because it focused my attention on the discrepancy between dialogue and image and I searched for connections between the two. On the other hand,

the choice of images displayed elements of Minimalism, not only in form because of their simplicity, but also because they supposedly addressed the 'essence' of the dialogue. The techniques used in the stage design certainly 'forced my awareness', making striking the obvious elements of the text that would otherwise have escaped me (Gattegno, 1985, p9).

Is this theatre experience relevant to my classroom? Well, I was very excited about the Proust play. I not only became more aware of disturbances, but also that these disturbances can be orchestrated, by changing the focus of attention and by stressing and ignoring the sameness and differences of these foci.

Metaphor

I could use the characteristics of metaphor to achieve a disturbance and stop me in my tracks, kick me into consciously making sense. Technically this happens because a metaphor transfers meaning from one thing to another. It is exactly this that creates a tension. A metaphor consists of two parts: the tenor, which is the object what it is about, and the vehicle, the term with which I connect the tenor or the object. In this way the tenor is brought in contact with the characteristics of the vehicle with the aim that these characteristics will become part of the tenor. Using a metaphor directs my focus of attention of the object to the vehicle which functions as a *b-object* and in doing so I look for connections between the two. An example I used

earlier in this chapter is

The shining blade of the light

(Vasalis, 1947, p14, my translation)

In this example, the ‘light’ is the tenor and the ‘shining blade’ is the vehicle. The aim of the metaphor invites comparison of the light with a shining blade. It connects my concept of light to characteristics of a blade, thus enriching my concept of the light and the way I perceive it.

Minimalism and Serialism

I could also use elements of minimalism to achieve a disturbance in the process of perceptualising which stops me from filling in gaps with default assumptions. To do this, I only show what I consider to be the ‘essence’ of the object. The absence of any other ‘fluff’ does not then distract learners from the essence I want them to contact, so they have to focus their attention where I intend. In this case the *b-object* is the object itself in its purity according to my perception. I could combine this with elements of serialism and use repetition to let the recipient re-experience the perceptualising time and time again with the aim of triggering a reaction of wanting to analyse the structure of the object. In this case the *b-object* the object itself, re-appears

time and time again so it stays in the focus of my attention. I could also include small variations in the repetition thus focusing attention on the differences and the sameness in the object's structure. In this case the *b-object* is twofold: the repetition of the same object so my focus of attention stays on the object, and the slight variations within the object so that my focus of attention zooms in on these elements of the object that are changing.

Asking 'good' questions

Another way of creating disturbances is by asking questions or giving prompts which function as questions. The question functions as a *b-object* and focuses my attention on a connection I, the learner, need to make to answer the question. Although I might not like the question, there will be something inside myself that will make me consider the question. As I mentioned earlier in this chapter when discussing why disturbances are needed, this happens according to Gattegno because questions and problems cause a tension. When I experience such tension, I will look for a solution, in an attempt to dis-solve the tension (Gattegno, 1984, p5). The question initiates connection making and mobilises energy within me to do this. Maybe this is, as stated earlier, because unconsciously I want balance and completeness.

Watson and Mason have published a book with examples of questions and

prompts that evoke mathematical thinking. Their rationale behind the choice of questions is that they should ‘promote thought about the structure of a concept. Such questions depend not on recall, but on students’ willingness to participate in a collective struggle for understanding. Answers are unlikely to be wrong in a traditional sense, because they are genuine responses to genuine enquiry, rather than a form of testing’ (Watson and Mason, 1998, p5). I have used these and similar questions with my students *and* with myself and they do indeed provoke re-thinking.

Example from the classroom

The following is an example of a task on non-integers incorporating such questioning that led to students of both a ‘top set’ and ‘bottom set’ year 7 to explore mathematics for nearly three hours:

Projected on the whiteboard are the following questions:

What is between 1 and 2?

Can you think of what else is between 1 and 2?

What is the same about these?

What is different about these?

Can you order these?

How do you order them? What do you do? What is your rule or method?

The questions provoked disturbances as I recorded in my research journal. They could be considered ‘good’ questions (Gattegno, 1985, pp12,15) because the students had to become aware and suspend their assumptions time and time again. For example the question ‘can you think of what else is between 1 and 2’ provoked the students to become aware and hold their assumptions that there was only 1.5, or that only decimals exists between 1 and 2. They had to re-think their thinking and change the focus of attention, enriching connections.

Questions such as ‘what is the same, what is different’ have a similar effect with something extra from the world of metaphors and mentioned earlier in this chapter: the comparison between different yet similar things enables us to see possible common elements between objects. Brown and Coles, mathematics educators and researchers in Bristol, concerned with issues of mathematics learning during transition from primary to secondary school, wanted to explore ways of establishing a classroom culture that would not only use and value students’ previous experiences, but also extend these (Brown and Coles, 2003, p140). The central teaching strategy they employed was the question ‘what is the same, what is different?’ and offered students contrasting examples. They argued this question works on different levels: initially one can see the familiar (the sameness) in the examples, an essential step, because ‘We take as given we can only bring to a context what we

already know' (Brown and Coles, 2003, p141). On a second level, it 'leaves the way open for you to use what you know to ask questions about the new' (Brown and Coles, 2003, p142). Their teaching strategy thus allowed the students to identify possible common elements in the examples based on their past mathematical experiences and practice, then build on this identification by comparing the different aspects of the examples. At the same time, enriching connections between the new and the old are developed. Akin to my experience of the Proust play, stressing the sameness and differences of the foci allows for this to happen. Questions as in the task on non-integers function as the *b-object* that focuses the attention on questioning the perception, i.e. overruling the unconscious Gestalt laws and pushing the student into looking at the structure of the object to see where it differs and where it is the same.

Art and Mathematical Thinking

My classroom examples are all drawn from mathematics because for me there is a deep connection between Mathematical Thinking and Art. Indeed, I see Mathematical Thinking as the Art of doing Mathematics of exposing structure and using this to address problems related to that structure.. Art is taken here as in its definition of 'the application of human creative skill'. Or as in 'branch of creative activity concerned with imitative and imaginative designs, sounds or ideas' (Elliott, 1997).

But I have a dilemma with the different sizes and intensities of mathematical thinking. For example what if a student says “I know 6×5 is not 35 because 6 is an even number and 35 is an odd number, so it must be wrong” or what if a student says about a pattern “it goes up in 3’s”. Is either of these Mathematical Thinking, the Art? Or both? Does Mathematical Thinking have to be a BIG idea, or can it be little as well?

Art according to Jauss

Looking for similarities in the literary world, I was inspired by Jauss’ theory of when Art happens in literature. Jauss belongs to the school of reception theory or aesthetic of reception elaborated earlier in this chapter. To recap, the *basis* of this theory of reception is a text automatically awakes memories from earlier texts, and triggers emotions, expectations and assumptions which is called the existing *horizon of expectations*. The new text affects the reader’s *horizon of expectations* which can be varied, corrected, altered or even just reproduced (Jauss, 1982, thesis 2, p23).

Jauss argues that Art happens when there is a *conscious* expansion in the reader’s ‘horizon of expectation’, as a result of new norms. His next thesis is elaborated as:

“If one characterizes as aesthetic distance the disparity between the given horizon of expectations and the appearance of a new work, whose reception can result in a ‘change of horizons’ through negation of familiar experiences or through raising newly articulated experiences to the level of consciousness. The distance of the change determines the artistic character of a literary work. The smaller the distance, the closer the work comes to the sphere of ‘culinary art’”.

(Jauss, 1982, thesis 3, p25)

What I think this means is that the process of conceptualising a text triggers past experiences, memories of what has been read before, and knowledge already held of the specific rules of the genre of text. Based on these past experiences expectations arise for what is to follow in the text. Hence the new text evokes for the reader this ‘horizon’ of expectations and rules. These expectations can be met, or changed, or re-orientated as the reader reads on. If there is a *conscious* expansion in this ‘horizon’ of expectations and rules, then Art happens. Hence for Art to happen the text has to provoke the reader to vary, correct or alter expectations and rules, through knowledge of the genre of the text. Jauss argues this can happen if the text disturbs the reader in such a way as to contradict previous familiar experiences or to make the reader conscious of new experiences resulting from the text. Jauss is specific

in the elements that make up this 'horizon of expectations' or the elements of knowledge of a text genre. These elements are:

- Knowledge of poetics and genre
- Texts from literary-historic surroundings
- Contrast between fact and fiction
- Contrast between poetic language and every day language.

(Jauss, 1982, thesis 3, p25)

For Art to happen requires a change in knowledge and awareness in any of these elements. The degree of the Art occurring can be 'measured' by the change in 'aesthetic distance', i.e. the size of the gap that has ensued from reading the new text between the elements of the reader's horizon of expectations before and after reading the new text; the distance of change. This implies that Art does not have to be BIG Art, but can also be small Art. However, as the distance of change tends to zero, the closer the work comes to 'culinary art', to 'recipe following' (see next page). The artistic character of the new text is determined by the distance of change. Hence, if the text can provoke a big change in horizon of expectation, then it is of high artistic character and could be considered by some to be Literature with capital L.

Jauss' idea of Art applied to Mathematical Thinking

Putting Jauss' theory into my view of Mathematical Thinking as the Art of

mathematics, I could now not only decide whether Mathematical Thinking was happening according to my definition, I could also look at the ‘artistic character’ of the input. This meant I could examine a task or a question and assess whether it had the potential to provoke Mathematical Thinking and its size.

To experiment with this I needed to define a horizon of mathematical expectations. Inspired by my personal experiences and similarities in Jauss’ definition of the horizon and devised this non-restrictive list:

Elements of horizon of literary expectations (according to Jauss)	Elements of horizon of mathematical expectations
Knowledge of poetics and genre Texts from literary-historic surroundings Contrast between fact and fiction Contrast between poetic language and every day language.	Knowledge so far of mathematics Experience with different task-types and schools of mathematics (e.g. geometry, statistics) Contrast between fact and fiction: could be the awareness of the difference between reality and its modelled representations (e.g. limitations and restrictions in word problems). Contrast between mathematical language and everyday language, including the issue of symbolism

The converse: junk mathematics

Interestingly I also find Jauss’ thinking on the converse perfectly compatible:

the case when Art does not happen, when the distance of change tends to zero, to 'culinary art'. Synonyms of this literary genre are 'consumption literature' or 'trivial literature'. Jauss argues that in such case the reading of the text will be

“precisely fulfilling the expectations prescribed by a ruling standard in taste, in that it satisfies the desire for the reproduction of the familiarly beautiful; confirms familiar sentiments; sanctions wishful notions; makes unusual experiences enjoyable as ‘sensations’; or even raises moral problems, but only to ‘solve’ them in an edifying manner as pre-decided questions”

(Jauss, 1982, p25).

Characteristics of such 'trivial literature' are described as acknowledging an existing order and offering a dichotomous, black/white view of the world. The reader is being forced into passive reading by creation of an illusory control of reality (hero happy-ending) and by naïve seriousness (Van Gorp *et al*, 1986, p424). Iser described it as literature in which “fulfilled expectation becomes the norm of the product” (quoted in Jauss, 1982, p197).

This explanation reminded me strongly of what Ahmed (1987, p15) refers to as 'Junk Mathematics', offering an analogy with junk food. In this kind of

mathematics practice, students are forced into passive participation with all 'preparation' completed by teachers or authors with 'all the nasties removed'. It reiterates the dichotomous view students have of mathematics by thus excluding disturbances and allowing for 'right' and 'wrong' answers only. It looks well structured and appears logical, but it is dull and lacks substance, because the students' thinking structure is not being challenged through the avoidance of 'nasties', thereby offering a sense of naïve seriousness. Most disturbingly of all, I find the students fulfilled expectation of this kind of mathematics learning becoming their norm of what mathematics is about.

Jauss' converse theory also describes what happens at times when I give my students certain bookwork to do and the students go 'through' the exercises. They complete the exercises happily, but I have the impression that their learning has been very limited, and this impression is reinforced when they cannot do similar exercises the next lesson. They have stayed in their comfort zone. Their existing thinking order is not being challenged. Examining the questions more carefully I notice that they are within strict parameters of a model example. The answers are either right or wrong, re-emphasising the students' view that mathematics is dichotomous. The answers always seem neat, no complicated decimal or surd insight, which gives an illusive control of reality. Their learning is 'triggered' and on the surface, because like metonymy, their thinking is based on substitution founded on association or

proximity. This limited indication of variation and lack of prompts hinder the students to go beyond their limited implicit assumptions about number, shape, etc. Frequent exposure to these sort of exercises reinforces mis-impressions about what mathematics is about, and what it means to do mathematics. It also trains expectations for the future, re-inforcing passivity.

Mathematical tasks analysed using Jauss' theory adapted to

Mathematical Thinking

Looking back at the questions of the task on non-integers and applying the Art-theory to it, I dare to say that the task indeed could potentially provoke Mathematical Thinking, as could Ollerton's task:

Elements of horizon of mathematical expectations	Potential changes in these elements resulting from Non-integer task	Potential changes in these elements resulting from Ollerton task
Knowledge so far of mathematics	Whatever previous knowledge students could gain a further insight into non-integers, not just decimals, and into the place value system with the effects on ordering non-integers	Students had knowledge of perimeter, a square, and maybe a notion of maximum before, but not of connection between the three concepts, neither of representing this in a generalized form, potentially in algebraic format

<p>Experience with different task-types and schools of mathematics (e.g. geometry, statistics)</p>	<p>Students had previous experience of this sort of questioning that would ask them to think and reflect – this task could help instil such questioning and potentially allow fading. Students had previous experience of number work, not so much of number theory</p>	<p>Students had previous experience of this sort of questioning that would ask them to think and reflect – this task could help instil such questioning and potentially allow fading. Students had previous experience of the separate concepts but not, I think, of linking geometry with number and algebra and with issues of proof</p>
<p>Contrast between fact and fiction: could be the awareness of the difference between reality and its modelled representations (e.g. limitations and restrictions in word problems)</p>	<p>If fiction is considered to be which non-integers students are exposed to in their ordinary life, such as incremental number lines in the form of their rulers, then yes, this task could create an awareness that such number lines are a fictitious representation of non-integers in so far that they offer a very restricted representation</p>	<p>Not sure about this</p>
<p>Contrast between mathematical language and everyday language, including the issue of symbolism</p>	<p>In the sense that ‘one and a half’ can be written in many forms, and that ‘about a half’ can have many different interpretations mathematically</p>	<p>Students had to express their visual observations into verbal expression into written symbolised expression showing the contrast between everyday language and mathematical language</p>

I would say that both tasks had the potential to lead to the Art of doing mathematics, to Mathematical Thinking. Considering the example of Bob and Shaun, I conjecture that both could have widened their horizons, depending of course on their horizons before they started the task. Assuming they started from the same horizon that did not include the experience of having generalized like this before or considered connections between such three concepts, then Shaun experienced the bigger Art, did the bigger Mathematical Thinking; and Bob experienced smaller art, smaller Mathematical Thinking, but still changed his horizon of expectation.

Presuming this conjecture holds, this would imply that conceptual conceptualising necessarily requires big-ish Mathematical Thinking, while perceptual conceptualising requires small-ish Mathematical Thinking with the danger of becoming Junk Mathematics or 'culinary art'. Earlier in this chapter I compared the effects of conceptual conceptualising with those of metaphor and the effects of perceptual conceptualising with those of metonymy. If this analogy is appropriate, then this would mean that metonymy can also provoke similar effects to metaphor, albeit different in size, and so should not be dismissed as the weak trope. One of its problems is, I think, that it is not as easily recognisable as metaphor, just as perceptual

conceptualising does not offer a blatant, loud and clear example of Mathematical Thinking.

Summary of this chapter

In the previous chapter I explored how the nature of emotions interrelates with the energy intensity of emotions experienced as felt arousal. I conjectured that being in a certain state is the result of having made sense of some input that triggers me into that state. In this chapter I continued my journey on the River of Energy and explored where it takes me in *the process of making sense*.

I first tried to capture different stages in the process of making sense, defining and using notions of input, percept, perceptualising, concept and conceptualising to help me distinguish these stages. I reviewed literature based on these categorisations and I examined similarities and differences of their views. While some, like Minsky, Vergnaud and Gibson approach the process of making sense from a point of view that sees the mind as an information processing system employing schemata, others such as Lacan, Bruner and Mason place this process in the narrative field, with language representing experiences. This made me see the mind as a creator of meaning. What they all seemed to agree on is that the process of conceptualising is

based on making connections through perceived similarities and analogies with our past experiences. The combination of the two schools of thought led me to approach the process of making sense from new perspectives, exploring ideas in linguistics, literary theory, psychology, the arts and in theatre.

As a first step in this journey I explored the concepts of metaphor and metonymy using a cognitive linguistics approach accounting for these tropes in terms of understanding of the human mind, and in specific the effects they seemed to have on energy flow and the causing of disturbances in the process of making sense. I analysed their characteristics and the effect on the 'reader' with the aims of 1) understanding the process of making sense better for myself, 2) being able to identify issues in my students' thinking, 3) becoming able to use characteristics of metonymy and metaphor in my teaching to achieve their associated effect and 4) becoming aware of subtleties in energy flow in the process of making sense.

Conceptual Art and Minimalism in particular seemed to achieve the same purposes as metaphors but from another methodology. By analysing its characteristics and effects I concluded that although paradoxical in many aspects to metaphor, they both had the power to overrule unconscious Gestalt laws of perception.

Another influential perspective on my explorations of the process of making sense proved to be Reader Theory which focuses on the effects that an input (a text in this case) has on the reader. It describes the period between input and output as a period of 'Unbestimmtheit' or 'indeterminacy', a virtual space where the 'implied' reader supplements the text with his or her own meaning making. What happens in that space remains therefore necessarily vague and is not observable. It is influenced by assumptions and expectations of the reader. This notion of 'Unbestimmtheit' raised questions in me about what is happening in the classroom in terms of my assumptions and expectations of the students' process of making sense.

Lacan's idea of 'signifying chain' that builds on this idea of 'implied reader' proved to be important in my thinking. He argues that there are no signifieds (being the concept or the real) in language, only signifiers (being the sound image or the symbolic). As according to Lacanian psycho-analysis the unconscious is structured as a language, there are thus no signified in the unconscious and no signified can be brought to consciousness. Meaning, he thus claims, comes from the correlation between signifiers. I combined this notion with the notion of Gibson's affordances and conjectured that it is affordances that give meaning to an experience.

In my quest for finding out what happens in the space of 'Unbestimmtheit'

with the aim to influence this stage in my teaching, I then inquired about the roles and existence of the elements of assumptions & expectations and disturbances in the process of making sense. In this period of 'Unbestimmtheit' I look, consciously or unconsciously, for similarities in my past experiences. In doing so I am making default assumptions about analogies, leading to expectations. I noticed that to become aware of 'wrong' assumptions made I needed disturbances, which I explored next. They proved to be important to learning as they disturb my existing thinking frame and energy flow, similar to the effects of metaphor and Minimalism. Disturbances make me change my focus of attention. I conjectured that focus of attention plays an important role in the process of making sense as it determines the similarity that triggers past experiences and this has implicitly significant consequences for teaching.

This conjecture in combination with Reader Theory led me to analyse how learning can be manipulated by developing teaching strategies that harness the focus of attention. As part of this harnessing strategy, I also needed ways to disturb my students in order to change their foci of attention. For this, I looked at the elements of the structure of causing disturbances that are used in stage-design in theatre, in metaphor, in Minimalism and Serialism and in asking what Gattegno coins 'good questions'. I used these identified characteristics to analyse tasks I had developed with the objective of

promoting conceptual conceptualizing.

I define Mathematical Thinking as the Art of doing Mathematics, but I always had a dilemma about its different 'size' and intensity. By referring to Jauss' theory of when Art in literature happens, I developed a modified model for Art in the context of learning mathematics, giving parameters to assess the 'artistic input' of a task and its potential for Mathematical Thinking. This led me to probe why some tasks do not offer this potential.

To summarize my conjecture of what happens in the process of making sense: The process of making sense consists of the process of perceiving followed by the process of conceptualising. Making sense is about making connections and looking for similarities and analogies in past experiences. This implies a great many varieties of interpretation both within one person and between individuals. Concepts formed of a certain input will therefore differ from moment to moment and from person to person. The process of perceiving is unconscious and largely physiological. It is subject to Gestalt laws.

Because I am looking for similarities, and I consider what I have perceived to be similar to a past experience, I am actually making an assumption that it *is* similar. Based on these past experiences, expectations that the perception will develop or behave as the previously experienced similarity is triggered. At

times expectations are not met which causes a disturbance, creating an imbalance, a tension which I will try to dis-solve by looking for an alternative analogy in my past experiences, and so repeating the cycle.

In the identification process of what it is I perceive, I am actually looking for a functionality or affordances of that perception – what it does, what can I do with it, what is its function thus attributing an intended purpose of the object.

In the next chapter I will explore *where* these past experiences are stored, the implications on *why and how* assumptions and expectations are assigned; *why* a certain similarity is selected as ‘true’ or ‘fitting’; and *why*, at times, it happens that the ‘wrong’ similarity is selected.

Chapter V: Selves

Why this chapter?

In my quest for finding what happens in the space of ‘Unbestimmtheit’ I am continuing my journey on the *River of Energy* to wherever it takes me. In the previous chapter this took me through the process of making sense where I explored not only what takes place but also how I can manipulate this process in my classroom. For this, I looked for inspiration in psychology, literary theory, arts and the theatre. I also inquired about the roles and the existence of certain elements of the process, i.e. assumptions & expectations, and disturbances.

In the process of making sense I look, consciously or unconsciously, for similarities in my past experiences. In this chapter I will explore *where* these past experiences are stored, the implications on *why and how* assumptions and expectations are assigned; *why* a certain similarity is selected as ‘true’ or ‘fitting’; and *why*, at times, it happens that the ‘wrong’ similarity is selected.

It is a journey looking for a virtual location where making connections to past experiences in the process of perceptualising and conceptualising takes place. I have noticed within myself that these places are different and that each comes with their own experiencing world. These virtual places I will describe as my Multiple Selves.

These words immediately raise the issue of what I will refer to when I write 'self'. Minsky approaches this problem as follows: he writes "self" when speaking in a general sense about an entire person and "Self" for talking about that more mysterious sense of personal identity (Minsky, 1988, p39). I will stick to the same notation.

What is meant by Selves

Literature review and my description

Although I subscribe to the notion of Multiple Selves because it seems to fit in with the image I have of these virtual spaces, I only see it as a way of grouping, of classifying in a virtual way, offering me a mental image to make sense of my being. I thus can find myself with Bruner's view that 'the notion of Self is purely a conceptual Self, created by reflection; a concept conceived and constructed like any other concept' (Bruner, 1990, p100). Views and understanding of concepts can change with time, or in different situations.

Blackmore, a psychologist with interests in, amongst others, consciousness and memes holds similar views and describes the notion of Self as a 'model' or 'constructions of a modeling system' (Blackmore, 1986, pp84, 85). She explains how change in the self model or 'I' happens as a result of 'altered states of consciousness' when the model of reality is altered. As Self is a model, it is altered as well (Blackmore, 1986, p80). I have thus no qualms with other ways of grouping or describing the notion of selves.

Lakoff, a linguist with an interest in cognitive sciences and a former student of Chomsky, describes Multiple Selves as a metaphorical model of the self inherent in our conceptual system. He argues that

“There is, within our conceptual systems and our language, an unconscious, automatically-called-up metaphorical conception of a locus of consciousness, will, and judgment separable from the body and the passions.....The study of our system of conceptual metaphors reveals that it is common for there to be many incompatible metaphorical models of important domains of experience.....The models aren't 'true', but they are useful in different situations, for different purposes, characterizing different perspectives. We also know that such metaphorical models, though there may be many of them, inevitably hide important

aspects of any domain and lock us in to certain ways of comprehending our experience. After all, our very concepts are defined by such metaphorical models, and we can only think using the concepts we have’.

(Lakoff, 1992, page 1).

Lakoff uses the expression ‘metaphorical model’. In the previous chapter I have elaborated on the difference between making connections based on metonymy and on metaphor. I do not think that Lakoff refers in his terminology here to a model based on a metaphorical connection made, but rather that the model of Multiple Selves is itself a metaphor, a ‘name or description to something which is not literally applicable’ (Elliott, 1997). Like Lakoff I consider the notion of Multiple Selves to be a model and label for a virtual space and as such I consider it metaphorical.

I have no physical proof this notion of Multiple Selves exists in any physical sense nor can I physically measure it or pinpoint where they are located in my body. Similarly to both Lakoff and Husserl (Husserl, 1964, p24), and as stated in Chapter 2 of this thesis, I am not concerned with whether this model is ‘truthful’. I use the notion of Multiple Selves for phenomenological reflection setting aside the question of real existence, and directing my mind towards this nonexistent or virtual object.

Assuming existence of Multiple Selves helps me to make sense of what is happening in my ordinary daily experiences, as well as in my professional life. I use it to identify experiences, energies and underlying phenomena.

Minsky (1988) considers how to define the concept of Self. He argues it might be better to stick with descriptions other people have offered him instead of trying to come up with a definition. He states that it ‘often does more harm than good to force definitions on things we don’t understand’ (Minsky, 1988, p39)

So, like Minsky, I will not ask myself ‘What are Selves?’, but ‘What are our ideas about Selves?’ and ‘What psychological functions do these ideas serve?’ (Minsky, 1988, p39). I will also ask myself ‘What functions do these Selves play in the process of making sense and what effect do they have on energy dynamics?’

Hence no definition, but descriptions.

I describe Selves as the virtual, imaginary place where my past experiences are stored.

I see myself as Els, one person and consisting of several personalities. Each of these personalities I consider a Self. Examples of these Selves would be

the mother-Self, the teacher-Self, the daughter-Self, the sister-Self, the host-Self, the caring-Self. All these Selves come with their own postures, body language, voice, gestures, and vocabulary. Each Self also comes with its own hierarchical social structure.

An example illustrating Selves come with their own language

When I find myself in my daughter-Self, conversations and thoughts happen in Flemish, my mother tongue, which is similar to Dutch but with different intonation and differences in dialect. The grammar is the same and Flemish people understand Dutch people very well. The other way around is not always the case because of the dialects involved in the Flemish language. My husband is Dutch and his family lives in The Netherlands. When I find myself in my daughter-in-law-Self: I find myself speaking and thinking in a very clean version of Flemish with certain Dutch vocabulary, e.g. ‘vergiert’ versus ‘stramien’; ‘pollepel’ versus ‘soepopscheplepel’. When in my mother-Self I speak a hybrid language of Flemish, Dutch and English. In my teacher-Self I make a very conscious effort to speak clear and correct English.

Experiencing being in different Selves – experiments for readers

The description above of how each of my Selves comes with, amongst others, its own language is, of course, my very own experience. I conjecture that each Self comes with more than just its own language. I have developed some

experiments to try to engage you, the reader, in experiencing being in different Selves. This experience fits in with the third method of validation of *reader experience* I aim to achieve based on the methodology of Discipline of Noticing and described in Chapter 2. The experience that what you, the reader, find coming to mind, becomes the data. The validity is thus *personal* and resides in whether future practice is informed. This practice has analogies to Iser's reader-response theory in that I *imply* you, the reader, in these tasks. I do not expect you to mine out an objective meaning hidden within these examples. On the contrary, they have been constructed with the aim that they *do* something to you and that this becomes the data.

The aim of the first example is to create an awareness that individual Selves come with their own physical postures and their own idiom:

Imagine you are entering a classroom. There are students in the classroom. You are their teacher. Think about your posture. How do you hold your back? How do you hold your shoulders? How do you hold your head? You are carrying some books. How are you holding them? How do you put them down? You greet the students. Think about your voice. How would you describe your voice and articulation? Think about the vocabulary you use. Think about your facial expressions. Where do you look? How do you 'cast your gaze'?

Imagine you are entering the supermarket. You are pushing a trolley. Think about your posture. How do you hold your back? How do you hold your shoulders? How do you hold your head? You are asking for some cheese at the delicatessen counter. Think about your voice. How would you describe your voice and articulation? Think about the vocabulary you use. You are holding the packets of cheese. How are you holding them? How do you put them down in your trolley? Think about your facial expressions. Where do you look? How do you ‘cast your gaze’?

Imagine you are at your mother’s home. You are entering her home through an open door. Think about your posture. How do you hold your back? How do you hold your shoulders? How do you hold your head? You greet your mother. Think about your voice. How would you describe your voice and articulation? Think about the vocabulary you use. You are carrying some magazines. How are you holding them? How are you putting them down? Think about your facial expressions. Where do you look? How do you ‘cast your gaze’?

Did you notice any differences? Did you notice any sameness? I would describe these examples respectively as being in my Teacher-self, being in my Routine-shopping-for-food-self (referred to later as Customer-Self), being in

my Grown-up-child-self (referred to as my Daughter-Self). When doing this experiment myself I noticed different postures, voice intonations, facial expressions, and vocabulary with each Self.

The next experiment is designed to explore the emotions, behaviour, reaction, expectations and hierarchical social structures associated with different Selves.

Think again about entering the classroom. How do you think the environment (in this case the students) will react when you enter? Imagine that when you enter, the students turn their heads towards you, turn it back and continue their conversation with each other. You greet them. They do not look up or show any sign of response. Think about your reactions. Think about your emotions. Think about your behaviour.

Think again about standing at the delicatessen counter. How do you think the environment (in this case the shop assistants) will react when you stand there? Imagine that when you stand in front of the counter, the shop assistants turn their heads towards you, turn them back and continue their conversation with each other. You greet them. They do not look up or show any sign of response. Think about your reactions. Think about your emotions. Think about your behaviour.

Think again about entering your mother's home. How do you think the environment (in this case your mother) will react when you enter? Imagine that when you enter, your mother turns her heads towards you, turns it back and continues reading the newspaper. You greet her. She does not look up or show any sign of response. Think about your reactions. Think about your emotions. Think about your behaviour.

Did you notice any differences in your emotions, behaviour and reactions between these Selves? Did you notice any different hierarchical structures between these Selves? Did you notice any sameness in these Selves? When I did this experiment, I experienced different emotions, behaviour, reactions with each Self. I also became aware that when the persons involved turned back their heads to continue with what they were doing before I came in, I had different expectations and made different assumptions in each Self.

These assumptions and expectations were strongly influenced by the implicit hierarchical structures of each Self. My Teacher-Self, triggered in the example with the students, came with the emotion of indignation when the students turned their back on me: hierarchically, in pecking order, Teacher-Self feels 'above' her students and expects them to listen, respond, comply with instructions, demands, even her presence. My Teacher-Self experienced an injustice as a result of the students' behaviour and felt angry. On the

emotions/energy diagram from Chapter 3, my Teacher-Self found herself in the sector of anxiety, feeling moderately repulsed, with a fairly high level of felt arousal.

My Daughter-Self, triggered in the example with Mother, experienced a sense of sadness and disappointment. My Daughter-Self feels hierarchically below Mother: Daughter-Self tends to comply with Mother, partly because she is Mother, partly because Mother is an elder. At the same time, my Daughter-Self expects 'caring' from Mother. If Mother ignores her, she feels rejected and sad. On the emotions/energy diagram from Chapter 3, my Daughter-Self found herself in the sector of anxiety, progressing quickly to boredom, feeling moderately repulsed, with a fairly low level of felt arousal.

My Customer-Self in the example of shopping is a bit more muddled. Hierarchically, she feels slightly 'above' the shop assistants because she is the client, and 'client is king'. My Customer-Self felt disgruntled, not content because of that. Also rules of polite engagement Customer-Self expects to be adhered to when shopping were not observed. On the emotions/energy diagram from Chapter 3, my Customer-Self found herself in the sector of anxiety, feeling slightly repulsed, with a moderate level of felt arousal.

The next experiment is to experience moving from one Self into another.

Imagine again you are the teacher on your way to students in the classroom. You are walking from the staffroom towards the classroom, in the corridor. You are walking with a colleague. You are talking to that colleague. You are approaching the classroom door. You say goodbye to your colleague who proceeds down the corridor. You open the classroom door and you enter the classroom.

Think about that moment when you move from Colleague-Self to Teacher-Self.

When doing this experiment myself, I noticed several things. When I said goodbye to my colleague, I started thinking about entering the classroom. I was preparing myself to enter my Teacher-Self. I noticed changing my posture, straightening my back. I also became aware I was changing my assumptions and expectations. For example: I was assuming that in my Teacher-Self I would be working on teaching and learning mathematics. My expectations were that the students would not be talking to me about the nice pair of jeans they saw in the shop which is something I did expect from my colleague. This mental image of what I expect to be in my Teacher-Self got stronger and stronger as I approached the door. The moment I open the door my Teacher-Self is overwhelmingly present. My posture changed further:

head up, chin tilted upwards. The opening of the door and seeing the students confirmed my expectations and slotted the Teacher-Self firmly into place. I had anticipated becoming a different Self and based this anticipation on past experiences.

Where do Selves come from?

With the above experiments I intended to illustrate certain characteristics of Selves, how each comes with their own identity, posture, idiom, behaviour, expectations and assumptions, hierarchy. As these Selves are so individual, I ask myself where do they come from? How do they come into existence?

A constructivist perspective sees Selves as a collection of practices constructed in order to cope with the onslaught of experience. A psychological constructivist sees them as cognitive and cognitively constructed; a social constructivist as socially enculturated through participation, and an emergent constructivist see Selves as a combination of the latter two. I perceive the Self as a virtual, imaginary place where my past experiences are stored, formed by previous happenings in my life and functioning as a categorized storeroom. Self has thus cognitive, affective and enactive components among others, giving it a rich structure.

Dennett, a contemporary philosopher with research interests in evolution, consciousness and in general aspects on the mind, writes about the origins of the Self. He does not refer to Multiple Selves, but to one Self. He argues that this single Self originates from self-preservation.

“You are setting out to preserve yourself. You are becoming selfish in a primordial form (which lacks most of the flavors of our brand of human selfishness)!. Limits of the Self are established because 'you are drawing to preserve yourself, you do not squander effort trying to preserve the whole world: you draw the line, you set yourself boundaries. [Hence] you are what you control and care for”.

(Dennett, 1989, pp3,4).

Dennett seems to approach the origins of the Self in terms of what it cannot include, in terms of limiting it, in a defensive kind of way. Although he uses, confusingly, also a notion of 'minimal-self' which he defines as 'something abstract which amounts just to the existence of an organization which tends to distinguish, control and preserve portions of the world, an organization that thereby creates and maintains boundaries' (Dennett, 1989, p4), and which shows similar elements as those from Selves of Multiple Selves, he tends to talk in terms of one Self, not Multiple Selves. Despite these differences, I do

find his theories interesting and useful.

I agree that each Self develops from 'you are what you control and care for' (Dennett, 1989, p4), but approached from an offensive point of view, thinking in terms of expanding the Self, letting it grow. A Self originates from what Self cares for, what interests Self, what Self has affection for. In that sense Self will take care of it, which implies a certain level of control, whether effectively or only in imagination. Each Self has a boundary, and analogously to Dennett's argument this is based on preserving that Self. I do not want, nor can I, preserve the whole world in one Self. Doing so would imply that all my experiences belong to one certain Self, contradicting the experience and notion of Multiple Selves. Selves begin as a collection of practices appropriate for coping with certain situations. They develop into habits, with locked in postures, gestures, tones, etc and associated emotions and feelings. These limit and constitute the cognitive perspective associated with that Self.

The exciting aspect of Selves I find is that they are flexible and experiences can be added to them. Selves are continually being created, developed and adjusted as life progresses, as life experiences are accumulated. Hence from the moment there is the tiniest seed for a new Self, which can be spawned from another Self, it can be built on, letting it become a completely new Self with its own identity, idiom, expectations and behaviour. This is what I find

so exciting, because this not only offers me a sense of infinity in developing myself, Els, in my ordinary life, but it is also an idea I can apply in the classroom to my students.

An example of developing Selves in the classroom

How teachers work on developing Selves in the classroom has been beautifully described in Watson *et al* (2003). Reporting on the Improving Attainment in Mathematics Project we wrote how the participating teachers wanted ‘to develop helpful learning habits’ and aimed at ‘creating new habits’ through ‘new routines which need constant repetition to become habitual’. The teachers worked on this in a variety of ways. Some examples given in the book are:

- To establish listening, aural questions were used at the start of lessons as a settling-down task.
- To establish effort, students were made to look at a problem on the board in silence, told that the aim was not for them to solve it, but to think about it, and then they were asked for ideas. Over time, as this became routine, more and more students actually *did* think about the given problem.
- To establish atmosphere, effort, concentration and memory, students in one class were given the same sheet of multiplication facts to complete

at the start of every lesson and worked through it in silence for 15 minutes. The aim was to complete more and more each time, to compete with previous personal best.

- To establish listening and concentration, answers were read out once only, very quietly.
- To establish the expectation that everyone would be thinking, students knew that any one in the class might be asked to answer, after some thinking time.

Watson *et al* summarized the process as:

“Behaviour can be altered, but it takes time, persistence and imaginative methods. Old habits have to be replaced by new ones over time. A ‘training’ approach (with clear expectations and rewards) might be effective. Anything which disrupts old expectations (including expectations of the teacher’s behaviour) is worth trying. Time has to be given in lessons to establishing new habits, and time must be given over several weeks for them to become ‘habits’.”

(Watson *et al*, 2003, p13)

Hence, with carefully crafted tasks and continuous effort, students developed,

or at times even created, a Student-Self that contained ‘studious’ characteristics in their behaviour, expectations and idiom.

Transposing past experiences to current situations

In the experiment of experiencing different Selves earlier in this chapter, my Observer-Self noticed that each different Self had different expectations.

Each Self had expectations of its behaviour, its emotions, its mode of thinking, its reactions. My Observer-Self also noticed expectations each Self had of their environment: of the students’ and mother’s behaviour, of their emotions, their mode of thinking, their reactions.

To make a distinction between these expectations I will make a distinction between the *domain* and the *co-domain* of the Self. The *domain* is determined by the role of the subject, in a grammatical sense, of the Self. All the expectations affecting the subject are also placed in the *domain*. For example, in my Mother-Self the subject is the mother, with expectations of myself as mother, hence these expectations are situated in the *domain* of the Mother-Self. The *co-domain* is determined by the role of direct object or indirect object in a grammatical sense. All expectations affecting this direct or indirect object are also placed in the *co-domain*. For example, in my Mother-Self, my son is the direct or indirect object, depending on the situation. My

Mother-Self has expectations of him as son, hence both he and these expectations are placed in the *co-domain* of my Mother-Self. However, if my (biological) mother is in her Mother-Self, then my dutiful Daughter-Self is in the *co-domain* of her Mother-Self. Accordingly, the hierarchical characteristics of a Self come from the hierarchical positioning of its domain and co-domain which determine the hierarchical distance between the two. These domains and co-domains are interdependent and the coherence of a Self is based on their fitting together.

Selves are the accretions and hence virtual locations of grouped past experiences. In the process of making sense, my perceptual system seeks similarities between input and past experiences. The similarity triggered will depend on the focus of attention. The similarity selected can thus be a clear object, the whole situation, the surrounding atmosphere, the people involved, behaviour, language, expressions, words, the response of others and so on, that will 'ring a bell'. These similarities can thus be found in the domain or co-domain of one or more Selves. In the action of a dominant Self emerging, the assumption is made that the similarity is indeed isomorphic to the element(s) in the Self. The Self has associated (default) assumptions about the perceived environment and its associated actions and reactions. Things go wrong when an inappropriate Self makes a wrong assumption about the isomorphism of the similarity, something that can happen very easily,

especially in unfamiliar situations. Minsky describes this process as ‘Frames are drawn from past experiences and rarely fit new situations perfectly’ (Minsky, 1988, p245). Things can also go wrong when there is an overlap between various domains and co-domains.

Example re-visited: Jill and exam stress

In the previous Chapter I used the example of ‘Jill and exam stress’ to illustrate how in the perceptualising process I had been taken over by similarities in my past experiences. I identified as similar the experience of not being able to do exam questions which, in that personal case, had been because of exam stress. I made ‘default assumptions’ about the information that I was missing from Jill that could have contradicted this decision and I had jumped to the conclusion that Jill’s situation was isomorphic to my past personal experience. The Self of the past experience, in this case my Student-Self, was triggered by a similarity in its domain as the role that I played in that Self was the role of subject. Something really complicated then happened. My focus of attention went to what happened in this Student-Self but my Teacher-Self was still present as well. These experiences and expectations of the Student-Self were absorbed into my functioning Teacher-Self, thus expanding my Teacher-Self. This integrating process resulted in changes in expectations: my expectations in the domain of my Student-Self were and still are that if something does not work, if there is something I do

not understand, I take the responsibility to do something about it. The expectations in my co-domain do not include expecting my teacher to take the responsibility to do something about it. In the case of Jill, not only did I assume that our experiences were similar with the same cause, I also transposed the expectations of myself in the domain of Student-Self onto the expectations of myself in the domain of my Teacher-Self.

Now, in my Teacher-Self, teacher is the subject of the Self and finds herself in its domain. In Jill's Student-Self, Els in her Teacher-Self, is the direct or indirect object and thus located in the co-domain. Something resembling Shakespeare's Comedy of Errors then happened: the expectations in the domain of my Student-Self were transposed to the expectations in my Teacher-Self and thus ended up, according to my sense of 'truth' in the expectations of the co-domain of Jill's Student-Self. I thus assumed that she would expect me, her teacher, situated in her co-domain, to take the responsibility to do something about her exam stress. That's a lot of assumptions I made and I am now not surprised that my focus of attention went to such a complex construction and the new Teacher-Self became dominant, disregarding all other potentially matching Selves. It also shows me the complexity involved in using past experiences to inform me, to make sense of a current input. Minsky had trouble with this aspect too, trying to decide which 'frame' fits or dominates. Even after the complex issue of which past experience is triggered based on similarity, it is not simply a

question of transposing that past experience into the current situation. I could not transpose the past experience of my Student-Self into the current situation, because in the current situation I was functioning in a Teacher-Self. Hence, what happened was that I adapted the experience of my Student-Self by substituting it into the function of my Teacher-Self with its own sets of expectations. The experience was being re-written *in function of* my Teacher-Self. I had no idea whether Jill had these expectations of me, or whether she wanted my interference. My Teacher-Self at the time neither cared nor was aware of any disparity, typical of '*teacher's lust*' (Boole, 1987, p11) I referred to in the previous chapter. I was so caught up in my Teacher-Self and in what I wanted to say as a Teacher-Self that my sensitivity and vulnerability to other possibilities was dulled.

Punctuation of events: issues of truth and expectations

The analysis of the incident with Jill also illustrates beautifully the relevance of the Gita's categorization of inference based on *time* positioning between the object and the analogy triggered. In this case, where I think things went drastically wrong was when I transposed my inference of *cause* of not being able to do an exam question onto Jill. Inference based on cause or antecedent is what the Gita calls '*purvavat*' (Sinha, 1987, p31). In case of Jill the percept

was 'not being able to do exam questions, which triggered the analogy of the preceding circumstance of is exam stress, because this is what past experiences tell me.

The Gita's categorisation based on a time-frame in relation to the object and its analogy triggered offers a certain interpretation of the punctuation of events. How important this punctuation is in the process of making sense, in the creation of expectations and in relation to a sense of truth is described by Jones (1977).

Jones, a social psychologist, explores social, psychological and physiological effects of expectations. He writes that punctuation of a sequence of behaviour 'serves to help the individual make sense out of what is going on and helps organize the ongoing interaction' (Jones, 1977, p123). Punctuation refers to the manner in which one organizes his or her perception of the sequence of events in an interaction, and disagreement about how to punctuate a given sequence of events appears to be the source of many interpersonal conflict (Jones, 1977, p122). Jones refers to an example of Watzlawick *et al* (1967) to illustrate this:

"Suppose a couple have a marital problem to which he contributes passive withdrawal, she nagging criticism. The husband will state

that the withdrawal is his only defence against her nagging, while she [will state she] is critical of him because of his passivity.

The husband's punctuation of sequences goes

nag - withdrawal - nag,

nag - withdrawal-nag;

while hers goes

withdrawal - nag - withdrawal,

withdrawal - nag - withdrawal.

[Both see their reaction] as a response, a reaction to the other's behaviour and not determining”

(quoted in Jones, 1977, p123).

Jones concludes that different participants may have different punctuation of sequences and can end up with totally different views of what has occurred in the interaction - even though they both observe precisely the same behaviours.

Having a different sequence of punctuation gives a different causal effect and a different sense of truth. When I, in the example of ‘Jill and exam stress’, had placed exam stress *before* not being able to answer exam questions, exam stress became the cause and this became my ‘truth’, convincing me I was right and so were my ensuing expectations. Now, imagine I had put the ‘exam stress’ event *after* not being able to answer examination questions, then

not being able to answer exam questions would become the cause of exam stress and I would have had a very different 'truth'. Maybe then I could have asked questions to find out what caused not being able to answer exam questions, which could have been, for example not knowing enough mathematics. My expectations would also have been very different.

Bruner (1990) explains the different views of an event – or story in his terms - from the perspective of the property of inherent sequentiality of the narrative, fitting the experience of Jill and her exam stress. He identifies this notion of sequentiality as a major reason why making sense of a story is so complex.

He writes:

“A narrative is composed of a unique sequence of events, mental states, happenings involving human beings as characters or actors. These are its constituents. They have not a life or a meaning of their own. Their meaning is given by their place in the overall configuration of the sequence as a whole – its plot or fibula. ... The act of grasping a narrative, then, is a dual one: (1) the interpreter has to grasp the narrative’s configuring plot in order to make sense of its constituents, which he must relate to that plot. (2) The plot configuration must itself be extracted from the

succession of events”

(Bruner, 1990, pp43, 44).

As I experienced in the example, the meaning I had given to its constituents was indeed based on my interpretation of the sequence of events, on its sequentiality. What I considered to be the succession of events on which I based my understanding of the ‘plot’, was different from Jill’s view. In particular, the start of the sequence was not the same. Hence, inference based on time positioning between the object and the analogy triggered seems indeed to have great consequences in the creation of expectations and sense of truth.

Finding myself in the ‘wrong’ Self

In the example with Jill, the critical conflict with transposing my experience onto Jill occurred when my dominant Self decided that not being able to do exam questions was caused by exam stress. At other times, conflicts can occur from finding myself in the ‘wrong’ Self.

An example: John’s visit

John was coming to visit me at my school. We had planned he would attend some of my lessons, we would talk, he would have lunch with

the mathematics department, then he would work with all the year 11 students. I had everything planned for the day, I had organized the practicalities. I had prepared myself. I had imagined how the day would develop, how I would behave and contemplated what Selves I was going to be in. John was early. When I drove into the car park he was there waiting already. This was not planned. This scenario I had not imagined. It unsettled me. Realizing how such a trivial thing was unsettling me, I became even more unsettled. In my planning, I would have been at school before John and I would have collected him from the reception area. Because John was early, this would be different. We were now to walk together to the school door, which was different from me walking on my own. When I walk on my own to the door, I do not have to be social and talk to someone else, I can think about whatever I want. Often it is the time I think about the day ahead and imagine what will be happening. I find myself on such occasions in a Preparing-To-Be-Self, and I enjoy and value being in that Self very much. Because John was early, not only were my expectations that I could be in that Self squashed, I also so wanted to be in that Self. And I could not, because I had to be in a Sociable-Self and make conversation. What I found myself doing on the walk with John towards the school door, was flicking between the two Selves. When John uttered something I was pushed into my Sociable-Self, but the

moment there was a silence, I switched back into my Preparing-To-Be-Self. I did not feel comfortable because I could not immerse myself in either Selves. I experienced this as a conflict, a conflict of interests. I tried to let go of my Preparing-To-Be-Self, because letting go of Sociable-Self was not an option as John's presence triggered me back into that Self, but I found I could not.

The example illustrates a conflict arising from having the urge to want to be in a different Self from the one I am triggered into, the one I feel I have to be in.

Conflict can also arise when I have to change or adapt an existing Self to a large extent to accommodate new input as the following example illustrates:

A second example: Attention seeking behaviour by the teacher

I had been working for some lessons on changing the learning of my Year 10 students. I had felt they were not thinking mathematically enough in the classroom, were not learning on a conscious level. They seemed to expect from me, the teacher, to spoon-feed them, to explain again and again, to come up with all the examples. I wanted them to become more independent and conscious learners. This lesson I had asked the students to make up their own questions which resulted in a

shift in their working pattern. What I wrote in my journal is how I, the teacher, responded to this shift.

I was sitting there and they were doing all the work, progressing all by themselves. I was just sitting there, doing nothing, looking at them. It was very beautiful, but I became very restless. I felt redundant. I did not know what to do. I had not seen them like this before. I was sitting at my desk. There were two tables set up with equipment (multilink cubes and small post-its) where the students could go when they wanted, requesting my help or not. Some girls were working on them. I walked over to the tables, but the girls did not require my assistance. I felt lost, not wanted. I moved back to my desk, sitting facing the class, my body turned at an angle, so my legs were to the side of the desk. I noticed I started wobbling my legs. Nobody else noticed. I decided I wanted to observe the girls, so I moved my body, sitting straight. I just sat there. And I felt my energy ebb away. I went to sit with my head in my hands. Sat up straight again and started thinking about what I would have for dinner that night. I looked around, the students were working, not watching me. I started fiddling with pieces of string, wobbling my leg, stretching my legs. I stood up and walked over to the window and looked outside. No reaction

from the students, they did not even glance up. I saw the primary school children outside doing PE. I said out loud “How cute”. Some students looked at me. I continued saying “the little kids outside doing PE”.

This example shows a conflict arising from being forced to change or adapt an existing Self to accommodate new input. Self finds itself without established habits and practices and so feels inappropriate, out of its depth. The change required a major overhaul of the existing Self that can be considered as creating a new Self albeit that many characteristics of the old Self could be found in the new Self. It is similar to the example of ‘John’s visit’ in that I wanted to be in a different Self from the one I felt I had to be in. The difference is that in this case it was me, the Teacher-Self who had instigated the change in the students’ Student-Self with the aim that this change, both in their Student-Self and my Teacher-Self would happen. But the old Teacher-Self still could not let go. I even provoked disturbances in order for my students to give me some attention the way they used to do from their previous Student-Selves.

To summarize so far:

I see Selves as virtual locations originating from grouped accumulation of experience. Each different Self has different language, hierarchy, body

language, thinking frame etc. Each Self has expectations of its and its environment's behaviour, emotions, mode of thinking, reactions. I further identified two inherent characteristics, which I labeled the *domain* and the *co-domain* of the Self. I explored what happened in a Self and the strong influence of punctuations of events on the triggering of a dominant Self which can cause conflict in the interpretation of 'truth'. Another conflict can arise from finding myself in the 'wrong' Self and consequently from not being able to let go of a Self.

Why is it so difficult to let go?

The examples in this chapter of 'John's visit' and 'Attention seeking behaviour' highlighted how reluctant I was to change a Self and let go of a Self. Other examples such as 'Jill and exam stress', 'Rolf's timekeeping' and 'Macy' in previous chapters illustrated how difficult it is to let go of assumptions, expectations, focus of attention. Why is it so difficult to let go, to change and acquire something new, being it a Self, assumptions, expectations or focus of attention?

Atherton's theory and exemplification

Atherton is an educationalist with a background of education in social work. His theory is based on a distinction between 'additive' and 'supplantive'

learning: additive learning concerns adding new knowledge or skills to an existing repertoire, supplantive learning calls into question previous ways of acting or prior knowledge (Atherton, 2002).

Piaget developed a theory coined 'biological equilibrium' to explain the flux of energy experienced from disturbances. This biological equilibration involves what Piaget calls *assimilation* when notions are integrated into previous thinking structures, resembling Atherton's 'additive learning', and *accommodation* when the thinking structure is adjusted (Piaget, 1971, pp 4, 5, 173), resembling Atherton's 'supplantive learning'. What I like about Atherton's theory is how he explains this as part of a theory of learning from a more social perspective, which resonates with my own experiences of teaching and learning.

According to Atherton, the source of such supplantive learning can come from being required, demanded, or forced, or from creeping up out of awareness. Acquiring a new Self, or new focus of attention, assumptions and expectations seem very similar to this. Atherton then identifies three stages in supplantive learning in terms of psychological costs which could be transferable to the general process of 'letting go' and 'acquiring' because of its analogies.

The first stage in Atherton's theory is *de-stabilisation*: in which the previous

way of thinking or acting is upset (Atherton, 2002). In my examples this results from being disturbed in my present way of thinking. The disturbance can come in a variety of forms: in 'Rolf's timekeeping' the disturbance came from my expectations that Rolf would remember the time, not being met three times. In 'Attention Seeking Behaviour' the disturbance originated from being ignored by the students, by not being able to fulfil several characteristics of my existing Teacher-Self. In 'Jill and exam stress' the disturbance was very explicit by Jill telling me Teacher-Self had it wrong; in 'John's visit' by being forced into a different Self while desperately wanting to be in a another one. In 'Macy' my dominant Self found itself in an emotional state it did not want to be in as it experienced this as very unpleasant. These perceptions do not tie in with the expectations of the domain and co-domain of my dominant Self, which as a result feels out of balance. Hence, all these disturbances un-balanced the dominant Selves, destabilised it because the thinking did no longer fit in the current thinking-frame, which in turn leads to the cognitive conflict and the reconstruction of meaning and learning which I discussed in the previous chapter.

The second stage in Atherton's theory is *disorientation*: the "trough" in which loss of competence and morale combine to make the learning difficult, and there is a considerable temptation to return to the "old way" (Atherton, 2002). A lucid example of this is 'Attention Seeking Behaviour' where the

dominant Self felt so lost and useless that it resorted to distracting the students' learning so that it could go back to being the Teacher-Self it was before they changed their working habits. In 'John's visit' this stage was manifested by the going back to the Preparing-To-Be-Self the moment there was a lull in conversation. In 'Macy' this *disorientation* stage was less prominent, which might be because it was a very conscious decision of me to change my focus of attention. In 'Rolf's timekeeping' it displayed itself by not becoming aware, ignoring the disturbance of my expectations not being met three times (and being late three times). With 'Jill and exam stress' this stage revealed itself when I could not act upon her information that I had it wrong and I continued talking about exam stress.

The third and final stage in Atherton's theory is *re-orientation*: the gradual climb out of the trough, which follows a similar pattern to the curve of "normal" additive learning' (Atherton, 2002). In the process of letting go it concerns the acquisition of the new Self, the new focus of attention, the new set of assumptions and expectations. Using the examples this relates to the 'what happened next'. With 'Macy' I had let go of my Punitive-strict-Teacher-Self and acquired a Researcher-Positive-Attitude-Teacher-Self which I embraced with a vengeance, as illustrated in my journal:

From the first lesson, I notice that indeed, I do not 'pick ' on her

that much anymore, because I am not confronted every time with seeing her not work. This carries on for about 5 lessons. I have become more relaxed, not always on the look out, more free, because I feel I do not have to intervene everytime to keep her on track. I have the freedom to ignore Macy if I want, to get on with how I want to teach. I am aware I am slowly moving into the positive zone. She is starting to fulfil my expectations. It is a very pleasant feeling, and I notice I start to smile at her again.

- With 'Jill and exam stress', I became aware of what had happened long after the lesson. Since then, I have become more careful with making assumptions, but unfortunately, I never found out what made Jill unable to answer these exam questions.
- With John, I succumbed to being a Sociable-Self and immersed myself in that Self.
- With 'Rolf's timekeeping' several things happened next. It was the incident that triggered me into becoming aware of the effect of making assumptions and led to very rich explorations in my Researcher-Self. It also resulted in entertaining discussions with Rolf about what his assumptions and expectations had been in comparison with mine and what the lively involving discussion had meant to him. In practical terms, I arranged the next appointments but with greater flexibility on

my part, putting the importance of time and meetings in a more relaxed perspective.

- With 'Attention Seeking Behaviour' – I wrote the 'what next stage' in my journal:

When the same class used the same method in a later lesson on a different topic, I felt better, not so overwhelmed anymore. I had thought about my reaction and concluded that when I allow the girls to use their own method of learning and of progressing, I am allowing them to propel themselves. I am allowing them to think for themselves. I value their thinking. I can let go of them, it's OK. I think one of the issues why I find it hard to let them think for themselves, is that I feel that I have to know how they think, that I have to know how they are progressing. Which, in reflection, is very controlling, Big Brother like. I have also noticed that if I have planned such a lesson and they do not use their own learning method, if they do not use this self-propelling action, I feel disappointed and sometimes even cross. They are not fulfilling my expectations.

The energy required for this process of de-stabilisation, disorientation and re-orientation can be sourced to the effect of disturbances as explored in Chapter

4 where I argued that disturbances result in experiencing a surge of energy. I attributed this surge to an inert wish for balance based on Gestalt theory and parallel to Piaget's theory of biological equilibrium.

Letting go and acquiring something new comes with a psychological cost, the extent of which varies from situation to situation. Sometimes it creates a humorous situation, at other times it is just confusing, in the worst case, it is very painful. Why this is will be explored next.

Back to Selves & linking psychological cost with diagram of

Chapter III

Using Atherton's theory, Piaget's view of accommodation and assimilation, theories about disturbances and my explorations in this and the previous chapter, I conjecture that moving out of a certain Self happens through destabilisation resulting from a disturbance. As Atherton's theory states, even the disturbance itself has a psychological cost. If the cost is high and negative, the experience can be in the form of pain. This pain can come from realizing that my current thinking structure can no longer be applied and that I have to let go. The pain can also come from changing my state of awareness, from becoming conscious as a result of disturbances, as discussed in Chapter 4. If the cost is high and positive, it can be in the form of euphoria, coming from the same sources as pain, but maybe combined with a sense of relief that

I do not have to stick to my current thinking frame, or with a sense of excitement that there are more possibilities. Dennett described it as 'Border crossings [between minimal selves] are thus either moments of anxiety, or, in a familiar reversal, something to be especially enjoyed' (Dennett, 1989, p4). This ties in with my contemplations about pain in Chapter 3, where I addressed the issue of pain in terms of hitting the boundary on my diagram which represents the maximum arousal at a certain moment in time in a certain state. The act of hitting the boundary is being caused by the upward part of the oscillation which corresponds with the *rajas guna*, the source of all activity. *Rajas*' two-sided character is described in the Gita as *rajas* being "characterized by activation, mobility, stimulation, passion and pain" (Sinha, 1987, p29). This two-sidedness of *rajas* of being the source of activity and the source of pain could be explained by the states right underneath the boundary on the graph, which are anxiety if it involves a negative emotion, or excitement if it involves a positive emotion. The *rajas guna* is being triggered into existence by the disturbance, which causes Atherton's first stage of de-stabilisation when my previous way of thinking or acting is upset. A reason why *rajas* is being triggered could be because this disturbance kicks me into awareness and, as argued in the section of metaphor, minimalism and conceptual art, activates my thinking and sense-making. Another interpretation comes from Gattegno's conjecture that problems and questions are a state of perceived tension within myself that make me look for solutions

to dis-solve this tension (Gattegno, 1984, p5). In the previous chapter I proposed that this energy to dis-solve comes from the tendency within myself to look for a balanced input as a result of Gestalt laws of perceptual organization. In both cases, the disturbances activate my thinking be it consciously or unconsciously.

King Oedipus

A beautiful example of this complexity is the story of King Oedipus, to which I referred in Chapter 1. Oedipus ended up in a tragic situation when he mixed up the Son-Self with his Husband/Lover-Self by marrying his mother; then his Son-Self became confused with his Righteous-Angry-Young-Man-Self by killing his father. Although he could not be blamed for the confusion of these Selves since he had no knowledge of this Son-Self at the time the other Selves presented themselves, the tragedy happens when the existence of this Son-Self became known to him. The disturbance that caused him to become aware of this is a dialogue with the shepherd who saved him as a child. As a result he realised the extent of the confusion of his Selves. The disturbance triggered the *rajas guna* in him, making him hit the boundary, the maximum felt arousal he can bear in his state of anxiety. The pain was so great, he blinded himself so he would not have to see light anymore, hoping that the extinguishing of the light would obscure his sinful Selves (Sophocles, 1988, p58).

Revisiting the example of my attention seeking behaviour I can see similarities. Although the arousal experienced by my Teacher-Self was not, luckily, on the same scale as Oedipus', I did experience a sense of pain because of conflict between my old Teacher-Self and my new Teacher-Self, which had some opposite characteristics. For example: dependent versus independent students with loss of thought control, changed hierarchical distance between domain and co-domain, use of different teaching strategies – less exposition, more questioning. The confusion between the Selves became imminent as a result of a disturbance in the form of a change in students' behaviour, which did not correspond with expectations in my old Teacher-Self. The *rajas guna*, source of activity, kicked in. My felt arousal hit the boundary, experiencing pain of rejection. I could bear no more and resorted to attention seeking behaviour.

For Oedipus, the fictitious lead character in the play, the confusion of his Selves led to extreme pain, but for the viewer, it created a sense of suspense and surprise. Switching Selves in literature can be orchestrated with that effect in mind. Arne Sierens, a friend and playwright, described how he constructs a play: he introduces a character that is showing a certain Self. The character's surroundings emphasize this Self and in my terms its domain and co-domain are thus clearly defined. This Self is often easily identifiable by

the viewer who relaxes in the harmonious atmosphere of the scene. Then, a disturbance is introduced, for example by the introduction of another character. Suddenly the viewer is confronted with an aspect that does not belong to the domain or co-domain of the present Self, but of another Self. The present Self is disturbed and a new Self emerges. The public awakes, is intrigued and experiences a sense of suspense and surprise. The process of identification with the new Self and relaxing in harmonious atmosphere of the scene is repeated but with some new insights (Arne Sierens, private conversation).

Switching Selves through humour

Switching Selves does not always have to be painful. The disturbance can also come from humour. Bakhtin (1986) argues that humour dis-solves hierarchical tensions of the epic. He writes:

“It is precisely laughter that destroys the epic, and in general destroys any hierarchical (distancing and valorized) distance. As a distanced image a subject cannot be comical; to be made comical, it must be brought close. Everything that makes us laugh is close at hand, all comical activity works in a zone of maximal proximity. Laughter has the remarkable power of making an object come up close, of drawing it into a zone of crude contact.

Laughter demolishes fear and piety before an object, before a world, making it an object of familiar contact. Laughter is a vital factor in laying down that prerequisite for fearlessness without which it would be impossible to approach the world realistically. The object is broken apart, laid bare (its hierarchical ornamentation is removed). One ridicules to forget.”

(Bakhtin 1986, pp. 23-24)

Bakhtin places the effect of humour in the epic, and in any situation that involves a hierarchical distance. He describes how the use of humour breaks this hierarchical pattern, because it brings the subject close to me, the reader, which is contrary to hierarchy's ranking and lets me forget its hierarchical ranking. The change in hierarchical distance as a result of humour consequently can lead to a change in Selves, as each Self comes with its own hierarchy.

It is what happened in the example of Macy, during the following scene:

One lesson, I notice Macy is trying to distract Samantha and that is not an easy job, because Samantha just works. And I focus on the techniques she is using to distract Samantha. On her body language, on her gestures. She tries to chat, leaning over to

Samantha. Samantha says something back, I think to the extent of 'I am working', because Macy moves back sitting straight in her chair. She keeps looking at Samantha. She turns her body towards the window, as if something interesting is happening outside. Samantha does not react. Macy turns back to sit straight. She must be really thinking about this. She has not noticed I have been looking at her the whole time. Some of the girls have noticed it and are looking at Macy as well. It is getting rather comical. Haha, Macy thinks of something else. She slowly moves her whole arm, not just her hand, over Samantha's exercise book. Bingo! Samantha looks at her and laughs. They chat together. Then Samantha notices the other students and I are watching. Macy looks up as well. I have to laugh. Macy turns red in the face and smiles with a grin. And she goes to work.

Notice the 'Haha' and 'I have to laugh'. Initially Macy was a distanced 'student-who-gets-on-my-nerves-and-who-pushes-me-into-a-Teacher-Self-I-do-not-want-to-be-Self'. Over time, my Researcher-Self was carefully developed to become dominant in order to move from an unpleasant and anxious state to a pleasant state. This Researcher-Self was still rather distanced from Macy. The moment I could see the humour in her behaviour, the moment I laughed, this hierarchical distance diminished. I experienced a

sense of 'togetherness'. My implicit fear of being forced into becoming a Punitive-strict-Teacher-Self simply disappeared. Over the next lessons an adjusted Teacher-Self appeared, with elements of Researcher-Self incorporated, reflective of Atherton's third stage of *re-orientation* (Atherton, 2002). This Self included new foci of attention, a new set of assumptions and expectations, manifested by the following entry in my journal:

Since then, when Macy is not working, which does not happen so often now, I look at her and when she looks at me, I tend to smile and shake my head. In most cases she goes back to work. She also feels more comfortable with me, coming to me and sitting next to me, to discuss her work. Her body language is relaxed. At times, she even 'lounges' over my desk, body bent over the desk, arms supporting her upper body.

From the experiment on finding myself in a Self earlier in this chapter I had noticed that each Self came with a certain hierarchical structure. Using humour can thus offer a pleasant disturbance that allows another Self, or an adjusted Self to emerge. Because of the 'pleasant' annotations of humour and the similar connections this triggers, this Self is more likely to find itself in a 'pleasant' state .

What happens when I find myself happily in a certain Self?

To get into a Self, assumptions of similarity are made which trigger me into that Self and awaken Self-specific assumptions, expectations, behaviour, idiom, energies, hierarchical structure. As long as no disturbances happen to make me question the appropriateness of this Self, to make me question the assumptions of similarity I have made, I can dwell in this Self, with all my energy flowing to the immersion of that Self. With no disturbance I find myself in a state of stability, I feel balanced.

Experiencing ‘jouissance’, being in flow

Being in a ‘fitting Self’ can be a wonderful experience, beautifully described by Bollas ‘fallings into simple self experiencing’, giving the example of being lost in conversation. He writes:

“Certain objects, like psychic ‘keys’ open doors to unconscious intense – and rich – experience in which we articulate the self that we are through the elaborating character of our response. This selection constitutes de jouissance of the true self, a bliss released through the finding of specific objects that free idiom to its

articulation”.

(Bollas, 1997, pp. 16, 17)

It is a state I experience regularly in my Researcher-Self, when my dominant Self is engrossed in making sense of things, in developing theories and conjectures, when I find these resonating in literature. At such moments, nothing can distract me, I do not hear people calling out to me, I can't remember whether I have eaten, I lose all sense of time of day and month of the year. I experience my Researcher-Self to the full, this state triggered by some idea, or reading, that allows me to find a language and to crystalize my thinking. It is pure bliss, *jouissance*.

Jouissance is the emotion that is experienced at the moment of optimal experience of being in a Self. According to Bollas it happens because the unconscious is articulated, triggered by certain objects. In energy terms I experience a well of energy boiling up in me that overflows into a solid river with a steady forceful flow. I can experience disturbances but not of such magnitude to force another Self to become dominant. I experience serenity, with my will, heart and mind focused on the same object. I can immerse myself completely in the Self and become involved in its activities. I have no attention left over for anything else, no worries, no distractions. It is the moment the process of making sense proceeds uninterruptedly, without

disturbances, hick-ups, thundering waterfalls, or deep pools with undercurrents. This is what Csikszentmihalyi, professor of psychology and education at the University of Chicago, describes as the structure and characteristics of 'flow' in his *flow theory* where he captures those moments in ordinary people's ordinary lives (and not in laboratory conditions) when they reach peaks of involvement that produce intense feelings of enjoyment and creativity. This state of optimal experience he coined *flow* (Csikszentmihalyi, 1997, pp27, 29, 30, 34).

According to Bollas the state of *jouissance* happens because the unconscious is articulated, triggered by certain objects, thus circumventing the need for consciousness to create narrative. Csikszentmihalyi views are not so different. He does not refer to the unconscious, but refers to the vanishing of an obstructing self-consciousness. He argues a person in *flow* is completely focused

"Because of the total demand on psychic energy.... There is no space in consciousness for distracting thoughts, irrelevant feelings. Self-consciousness disappears, yet one feels stronger than usual".

(Csikszentmihalyi, 1997, p31).

I feel enthralled by these notions of *jouissance* and *flow*, not only because they resonate with my own experiences, but also because they are so positive and constructive. Flow theory is used in education where the state of flow exemplifies task involvement associated with a high level of positive affect. It offers a way to find optimization of learning conditions when a sense of effortless action is experienced (Csikszentmihalyi, 1997, p29). This implies the learners find themselves in a state with inert sustaining energy.

“When a person’s entire being is stretched in the full functioning of body and mind, whatever one does becomes worth doing for its own sake; living becomes its own justification. In the harmonious focusing of physical and psychic energy, life finally comes into its own”

(Csikszentmihalyi, 1997, p32).

It is a state my Learner-Self would like to be in because my energy is used very efficiently for learning. I learn for the sake of learning, with intellectual engagement its own reward. I thus learn because of an intrinsic interest in the object of learning making me less susceptible and reliant on external circumstances, similarly to Csikszentmihalyi’s analysis of happiness:

“We can be happy experiencing the passive pleasure of a rested body, a warm sunshine, the contentment of a serene relationship.

This kind of happiness is very vulnerable and dependent on favorable external circumstances. The happiness that follows flow is of our own making, and leads to increasing complexity and growth in consciousness.”

(Csikszentmihalyi, 1997, p32)

Seeing a student in a state of flow in my Teacher-Self would make me very happy, triggering a sense of aesthetic, of beauty. Also, it would allow me to develop a desired Facilitator-Teacher-Self, who smoothes the progress to learn and love mathematics without major distractions.

Csikszentmihalyi identified characteristics of flow and flow activity, useful for task designs that induce flow in learners. They are, in short: clear goals, relevant and immediate feedback, challenges and skills high and in balance, with lots of harmonious experiences triggered (Csikszentmihalyi, 1997, pp29-31).

In the context of my explorations in this thesis I find especially of interest:

- in moments of flow, consciousness is full of experiences, and these experiences are *in harmony* with each other. Hence, there is no confusion about locating these experiences, no confusion about Selves, nor its domains and co-domains. It is this sense of harmony that allows

a person to dwell in a Self, to experience *jouissance*, because the dominant Self is not being challenged or disturbed.

- activities that induce flow allow a person to focus on goals that are clear and compatible. Hence, for flow to happen the focus of attention needs to be clear and ordered. According to phenomenological philosophy, an experience is given direction and structure by the *intentionality* of the object of the experience which will only happen if this object has *meaning* or *content* in the sense of *essence* (Husserl, 1964, pp43, 44). I argue that for learners to experience ‘goals’ that are also ‘clear’, the object of their experience or study needs to have *meaning*. If the object is a mathematical concept, than the *meaning* would be found in the *mathematical meaning* of that concept, in all its complexity.

I found the following particularly interesting:

“Each of the flow-producing activities requires an initial investment of attention before it begins to be enjoyable”

(Csikszentmihalyi, 1997, p68).

This can partly explain why motivational theory alone might not work. As mentioned in Chapter 3, I consider my enquiry different from an enquiry into

motivation, because although I might have the motivation to do something or to move to another state, it does not imply I will succeed because I might be stopped in or diverted from that path. As mentioned in the same chapter, Mandler attributed this blockage to discrepancies between what is expected and what is perceived (Mandler, 1989, p13). In a Learner-motivated-to-get-into-a-state-of-flow-Self my expectation is to get into flow. However, my perception of the delay to reach this flow is contrary to that expectation. My Learner-motivated-to-get-into-a-state-of-flow-Self experiences this as a disturbance and stops being dominant as another Self is triggered. Being aware of this in my Teacher-Self is a great advantage. In my classroom my Teacher-Self can work on enculturating an ethos where students are supported during this initial investment period. Such practice has been observed in the Improving Attainment in Mathematics Project, where teachers changed assumed statements such as students 'cannot concentrate, cannot listen' to students 'do not concentrate, do not listen' and then created lessons in which the students did concentrate and did listen, developing new habits and routines (Watson *et al*, 2003, p14).

In Chapter 4 I explored characteristics of task design that stimulate what I call the Art of doing mathematics: Mathematical Thinking. I based this analysis in an adaptation of Jauss' theory, arguing that Art of doing mathematics happens when there is a change in the *horizon of expectations* of the learner. Elements

of this *horizon of expectations* in the realm of mathematics learning were knowledge so far of mathematics, experience with different task-types and schools of mathematics, contrast between fact and fiction, contrast between mathematical language and everyday language including symbolism and possible others.

My Teacher-Self nirvana is to get my students into a state of flow *while* doing Mathematical Thinking. Juxtaposing flow theory and these ideas on task design to achieve Mathematical Thinking, offer me a multi-layered, multi-faceted framework, structure and direction for analysing task design. Being able to construct tasks that have at least the potential to lead to flow and Mathematical Thinking I find very, very exciting as a mathematics educator.

Summary of this chapter

In this chapter I continued my quest for finding what happens in the space of ‘Unbestimmtheit’ in the process of making sense with the aim of finding ways to influence this period in the learning of my students. I continued my journey on the *River of Energy* to develop an awareness of what is happening. In the previous chapter this took me through the process of making sense where I explored not only what takes place but also how I can manipulate this process in my classroom. For this, I looked for inspiration in psychology,

literary theory, linguistics, the arts and the theatre. I also inquired about the roles and the existence of certain elements of the process, i.e. assumptions & expectations, and disturbances.

In the process of making sense I look, consciously or unconsciously, for similarities in my past experiences. In this chapter I explored the virtual space of where these past experiences are stored. I noticed within myself that these places are different and that each comes with their own experiencing world. These virtual places where grouped and accumulated past experiences are stored I described as my Multiple Selves who in turn are the outcomes of my making sense, my meaning construction. The remainder of the chapter probed its characteristics and implications.

I first reviewed literature on the notion of Selves and developed a description of Multiple Selves. I conjectured each comes with its own language, behaviour, thinking frame, assumptions & expectations and hierarchies. I investigated where Selves come from and based on these findings, I analysed classroom practice with the aim of identifying and developing Selves when teaching and learning.

An essential element of the Self is its associated expectations triggered by assumed similarities and analogies made in the process of making sense. I

probed this idea using my own experiences as a teacher, which led me to make a distinction between the domain and co-domain of each Self. Implicitly this means that each Self comes not only with expectations and default assumptions of its domain but also of its co-domain, that is of its environment's behaviour, emotions, mode of thinking, reactions. I argued these domains and co-domains to be interdependent and the coherence of a Self is based on their fitting together, giving a sense of balance. I conjectured that it is the non-correspondence of analogy of these elements in the process of making sense that are often the cause of a 'wrong' Self being triggered. This can be, amongst other things, because of 'inappropriate' punctuation of events.

Being in the 'wrong' Self causes conflict and disturbance because expectations are not met. I also noticed the difficulty of letting go of a dominant Self. I used Atherton's theory of learning to investigate this phenomena, incorporating Piaget's view of assimilation and accommodation.

I investigated the psychological cost of pain in letting go and switching of Selves linking it to findings of Chapter 3, using the examples of Oedipus and of 'My attention seeking behaviour'. I conjectured that switching Selves is not necessarily painful and can also be achieved through the use of humour based on Bakhtin's view of the effect of humour on hierarchical distance.

The final part of this chapter concerned explorations of what happens when I find myself happy and immersed in a ‘fitting’ Self, experiencing a sense of *jouissance* and *flow*. I elaborated on the characteristics of this state and looked at the pragmatic consequences of incorporating these ideas into task design to achieve such state in my students and fulfilling my Teacher-Self nirvana of students reaching a state of flow while thinking mathematically.

Chapter VI: Summarizings

Summary of ideas in this thesis

In the first chapter I talked about how this enquiry into energy dynamics came to be awakened. I described how at first I noticed a change in my levels of energy when reading literary texts depending on its genre; how I also became aware that tensions can be created and cultured by playing with the mixing of different Selves; how, when I started teaching mathematics, this notion of energies was re-awakened by my mentor who believed that teaching was about energy exchange between the teacher and the students; and how I started acting on this awareness by experimenting in order to influence energy levels and types of energy within myself and with my students. I talked about questions that arose such as what are these energies, and can I define them? How do they get triggered, how do they get to be there? Are these relevant to my teaching? Can these energies be manipulated, because that would be useful in my classroom? Can I find out what is beneath these energies?

In Chapter 2, I attended to the nature of this enquiry, probing issues such as looking for the phenomena, working with virtual concepts, and exploring the

principles of phenomenology and ways of working within the Discipline of Noticing.

Chapter 3 marked the beginning of my journey of discovery into energy dynamics. I described how I worked on educating myself to becoming aware and on developing sensitivities to the phenomena hidden within me with regards to energy dynamics and how I made myself vulnerable to these notions. I thus became aware of emotional states having a direct effect on energy levels and developed my sensitivities to these in the teaching and learning of mathematics.

I created a mental image of this in the form of a diagram illustrating the relationship between the nature of emotions and energy intensities experienced as felt arousal. This allowed me to make a distinction between emotions and energy, to explore their co-existence and interactions.

The diagram helped me make sense of the interrelation between emotions and energy in terms of quantity, direction and nature. I was inspired by literature from psychology and psycho-analysis, supplemented with insights from the Gita to find a vocabulary and a conceptual framework to illuminate these phenomena within me, to relate this to cognitive processes while at the same time not separating them from emotions as approached in non-cognitive

psychology and psycho-analysis. I used Mandler's description of emotion to identify two of its characteristics. I illustrated how Apter's classification of 'states of mind' helped me to analyse and describe incidents in the classroom. I explored how I move from one point on the graph to another point, in the form of oscillations, using ideas from Bollas and the Gita. By looking at the size and directions of these oscillations I further incorporated ideas from Mandler and Apter and argued oscillations happen in the process of perception of the nature of the emotion, in the process of making sense.

The diagram aided me to become sensitive to issues relating to emotion and energy, and guided me first in the understanding, and later in the manipulation of emotions and energy manifestations. It allowed me thus to manipulate energy levels and the effects of affect on learning and teaching and helped me, the teacher, to move from reacting to responding in my classroom.

Hence in Chapter 3 I explored being in, and manipulating an emotional state and its associated energy. I conjectured that being in a state is the result of having made sense of some input that triggers me into that state. The question I asked myself was "how did I get in that state"?

Chapter 4 addressed this by exploring what happens in the process of making sense. I first distinguished the different stages in the process of making sense as input, perceptualising, percept, conceptualising and concept. I reviewed literature based on this categorisation and I examined similarities and differences of their views.

I discerned two major schools of thought: those perceiving the mind as information processor and those perceiving it as a creator of meaning making in the realm of the narrative. I found myself subscribing to both. What they all seemed to agree on is that the process of conceptualising is based on making connections through perceived similarities and analogies with our past experiences. The combination of the two schools of thought led me to approach the process of making sense from new perspectives, exploring ideas in linguistics, literary theory, psychology, the arts and in theatre, with the aim of: 1) understanding the process of making sense better for myself, 2) being able to identify issues in my students' thinking, 3) becoming able to use identified characteristics in my teaching to achieve their associated effect and 4) becoming aware of subtleties in energy flow in the process of making sense.

I first explored the concepts of metaphor and metonymy using a cognitive linguistics approach accounting for these tropes in terms of understanding of

the human mind, and in specific the effects they seemed to have on energy flow and the causing of disturbances in the process of making sense. I conjectured metaphor had the power to disturb my thinking and to overrule unconscious Gestalt laws of perception. Such similar aspects I found in Minimalism and Conceptual Art. Analysing their seemingly paradoxical characteristics made me aware of subtleties in the outcome of the process of making sense that resonated with my experiences as a teacher.

Another influential perspective on my explorations of the process of making sense came from Reader Theory that focuses on the effects an input (a text in this case) has on the reader and uses the notion of 'Unbestimmtheit' to describe the virtual space between input and output where the 'implied' reader supplements the text with his own meaning making. What happens in that space remains therefore necessarily vague and is not observable. It is influenced by assumptions and expectations of the reader. This notion of 'Unbestimmtheit' raised questions in me about what is happening in the classroom in terms of my assumptions and expectations of the students' process of making sense. It also liberated my thinking as it offered me a way to bridge this division between the school that perceives the mind as information processor and the school that perceives the mind as a creator of meaning.

Lacan's idea of 'signifying chain' that builds on this idea of 'implied reader' also proved to be important in my thinking. Based on his conjecture that there are no signifieds (being the concept or the real) in language and that the unconscious is structured as a language, he argues that meaning comes from the correlation between signifiers in the 'signifying chain'. I combined this notion with that of Gibson's affordances and conjectured that it is affordances that give meaning to an experience.

Combining these theories with my overall aim of finding ways to influence my students' learning, I set out on a quest for finding out what happens in the space of 'Unbestimmtheit' with the objective of discovering ways to influence this stage through teaching. I reasoned that in this period of 'Unbestimmtheit' I look, consciously or unconsciously, for similarities in my past experiences, making default assumptions about analogies, leading to expectations. I noticed that to become aware of 'wrong' assumptions I needed disturbances to interrupt my energy flow and to change my focus of attention. I enquired about the roles and existence of assumptions, expectations, disturbances and focus of attention in the process of making sense. I conjectured that focus of attention plays an important role in the process of making sense as it determines the similarity that triggers past experiences and this has implicitly significant consequences for teaching.

This conjecture led me to analyse how learning can be manipulated by developing teaching strategies that harness the focus of attention. For this, I looked at the elements of the structure of causing disturbances that are used in stage-design in theatre, in metaphor, in Minimalism and Serialism and in asking what Gattegno coins ‘good questions’ which I used to analyse tasks I had developed with the objective of promoting Mathematical Thinking.

I defined Mathematical Thinking as the Art of doing Mathematics. By referring to Jauss’ theory of when Art in literature happens, I developed a modified model for Art in the context of learning mathematics, giving parameters to assess the ‘artistic input’ of a task and its potential for Mathematical Thinking and this led me to probing why some tasks do not offer this potential.

Hence, by the end of Chapter 4 I had developed my understanding of what happens in the process of making sense and constructed a framework for analyzing task design. However, I still did not quite understand why sometimes even the most beautifully designed tasks do not seem to work with my students.

Chapter 5, therefore, looked at where these past experiences are stored, the

implications of why and how assumptions and expectations are assigned; why a certain similarity is selected as 'true' or 'fitting'; and why, at times, it happens that the 'wrong' similarity is selected, basing my explorations on the notion that in the process of making sense I look, consciously or unconsciously, for similarities in my past experiences.

I described these virtual places where grouped and accumulated past experiences are stored as Multiple Selves. Using literature and my own experiences I conjectured that each comes with its own language, behaviour, thinking frame, assumptions & expectations and hierarchies. By investigating where Selves come from I analysed classroom practice with the aim of identifying and developing Selves when teaching and learning, my aim still being to find ways to influence meaning making in my students in the period of 'Unbestimmtheit'.

I noticed I sometimes find myself in the 'wrong' or inappropriate Self. Looking at the associated expectations of a Self triggered by assumed similarities and analogies made in the process of making sense led me to make a distinction between the domain and co-domain of each Self. I argued that these domains and co-domains are interdependent and that the coherence of a Self is based on their fitting together, giving a sense of balance. I conjectured that it is the non-correspondence of analogy of these elements in

the process of making sense that are often the cause of a 'wrong' Self being triggered. This can be, amongst other things, because of 'inappropriate' punctuation of events. I argued that being in a 'wrong' Self comes essentially from expectations not being met, leading to cognitive dissonance and resulting in internal conflict. I also noticed the difficulty of letting go of a dominant Self. I used Atherton's theory of learning to investigate these phenomena, incorporating Piaget's view of assimilation and accommodation.

Supported by these ideas I investigated the psychological cost of pain of letting go and switching of Selves. I also found that switching or letting go of a Self is not necessarily painful and can also be achieved through the use of humour based on Bakhtin's view of the effect of humour on hierarchical distance.

I then moved on to exploring what happens when I find myself happy and immersed in a 'fitting' Self, experiencing a sense of *jouissance* and *flow*. I elaborated on the characteristics of this state and looked at the pragmatic consequences of incorporating these ideas into task design to achieve such state in my students, my Teacher-Self nirvana of students reaching a state of flow with inert sustaining energy while thinking mathematically thus being fulfilled.

Juxtaposing flow theory and ideas on task design to achieve Mathematical Thinking, offers me a multi-layered, multi-faceted framework, structure and direction for developing and analysing tasks. Being able to construct tasks that have at least the potential to lead to flow and Mathematical Thinking I find very, very exciting as a mathematics educator. But that is not all. The development of a diagram showing the correlation between energy intensities and emotions and my explorations of making sense, metaphor, Minimalism, stage design and Selves, give me a complex metaphorical model and framework I can use in the analysis of teaching and learning mathematics in general. This gives me hope, courage and power because it offers me a tool to manipulate emotional and cognitive states, to recognize and possibly understand strange behaviour within myself and my students. Above all, teaching strategies that cater for this give me the possibility to manipulate energy dynamics, to manipulate that which gives the power to do something which in the end, I consider the pragmatic aspect of pedagogy: if there is no energy, no power, things will not get done, including learning. As Skemp says: teaching is 'an intervention in the learning of another person' (Skemp, p264, 1979). Manipulating energy dynamics in my teaching can thus intervene in my students' learning, helping them to learn.

It is difficult to express my total excitement about these findings.

Critical contemplations

On Energy

Energy dynamics is the title of this thesis. I am aware that my theorisings, conjectures and examples have not always made reference to energy. My first and most obvious critique is therefore: what happened to my enquiry into energy dynamics?

Initially, I found it difficult to describe subtleties in energy dynamics because I lacked the vocabulary. Later on, although including descriptions of energy from time to time, it was the way I had set out to use energy dynamics in my enquiry that proved obstructive. As described in Chapter 2, I intended to use my sensitivities of subtleties in energy experiencing to discover underlying phenomena in me, to guide me in what Csikszentmihalyi describes

“The only path to find out what life is about is a patient, slow attempt to make sense of the realities of the past and the possibilities of the future as they can be understood in the present.”

(Csikszentmihalyi, 1997, p4)

I used the notion of ‘River of Energy’ as a metaphorical path to experience

human dynamics of life as it took place in my experiencing world. The metaphor guided me to discover and explore phenomena hidden behind these dynamics. I was able to do so because I could make myself aware to *sensing* energy intensities and flows. What this thesis so far has reported on is what I found *on* that path, while not describing the path itself.

I will offer an illustrative description of a possible scenario of that path, of my River of Energy next. I will describe energy dynamics experienced in my sense –making process, starting from the moment of input, using the familiar example of ‘Macy’.

Macy

Macy has been getting on my nerves over the last couple of weeks.

She is an able mathematician, 14 years old and not in the mood for working at the moment. On top of that she chooses to sit right in the middle of the classroom so she is always in my view.

For the purpose of offering a way to account for the mainly unconscious process of experiencing energy dynamics in my process of making sense, I will consider the image of Macy sitting in the middle of the classroom and not working as the ‘input’ of the process.

My eyes discern this input. This triggers a flow of energy that feeds my physiological process of perceptualising. This physiological process requires

focusing on that which I discern to get a sharp and clear image. Energy is being channelled, directed in one direction, the input and flowing steadily. I will call this 'energy from direction'. I reach the point of percept when the object of Macy sitting in that position is being impressed on my mind. I 'see' Macy now. My energy flow temporarily stops flowing, gathering in a reservoir, and building up for a potential surge of energy. I will call this 'energy from finishing', in this case finishing the process of perceptualising. But what does perceived object 'mean'? This question causes a tension in me and an impetus to dis-solve it. 'Energy from asking a question' is triggered feeding the search for analogies and similarities in past experiences. Based on the physical element of the situation of me standing in front of a class and Macy sitting on a desk, the analogy is placed in my Teacher-Self. With its assumptions, expectations and the thinking frame of that Self are activated. The question 'what does the situation mean in the thinking frame of my Teacher-Self, what is its affordance or functionality?' triggers anew 'Energy from asking a question'. A student not working is not part of the co-domain of my Teacher-Self. My expectations are not being met. This disturbance causes my energy flow to halt, to hit a rock.

Every time I look at her, she is not working. And because of where she is sitting, I always see her, constantly, not working. Students who are not working disturb me. Seeing it constantly

greatly disturbs me and I make constant remarks to her to keep her on task.

By observing Macy not working time and time again, this process keeps repeating. The disturbance unbalances my Teacher-Self. My inert urge for balance produces a well of energy to act. This at first results in prompting Macy to work, which my Teacher-Self keeps repeating and repeating resulting in Macy claiming I am picking on her.

Macy says I am picking on her. She is absolutely right. But I cannot ignore her. I am aware that I am in the unpleasant zone of my graph and I get more and more agitated, and it is not constructive. It is getting rather confrontational and the atmosphere in the class is changing.

The situation is deteriorating. I keep experiencing the same process, the same disturbance. It manifests itself in a sense of frustration of not being able to fit Macy into my Teacher-Self co-domain. The energy activated by the disturbance is getting more intense, maybe also because there is now a sense of anticipation for what is to come. I never come to experience 'energy from finishing' my conceptualising process because I cannot make sense of what is happening. Tension is not being dis-solved. I experience turmoil with high levels of arousal as my 'normal' flow of energy is constantly disrupted. I reach the point that I cannot take it any more.

I take a decision I want to move to the pleasant zone. First I have to cross the neutral zone. To do that, I decide to put all the girls in set places, placing Macy in the back left hand corner of the class, out of my general view, so I will not be confronted all the time with what she is doing. I also place her next to Samantha, bright, very hard working, with a good sense of humour and a friend of Macy.

By moving Macy to another desk in the classroom, I am reducing the number of times the same disturbance of observing Macy not working can happen as I remove her from my visual plane. I am also influencing the input in the anticipation that Samantha working will make her work again and the image of Macy not working will no longer exist. The intense emotions I had previously experienced prompted energy in me to look for another solution. It made me look for other alternative analogies in my past experiences. I explored and analysed the characteristics of the situation, resembling the thinking frame of my Researcher-Self which in turn became dominant and came up with a suggested solution.

From the first lesson, I notice that indeed, I do not 'pick ' on her that much anymore, because I am not confronted every time with seeing her not work. This carries on for about 5 lessons. I become aware that Macy is slowly gaining trust in me again, she is

becoming willing to answer questions, to volunteer information, to share her ideas, but not yet to come and ask me for help. I have become more relaxed, not always on the look out, more free, because I feel I do not have to intervene every time to keep her on track.

Being in a more neutral zone, I have the freedom to ignore Macy if I want, to get on with how I want to teach. Because she is becoming more active in the class and participating, I am aware I am slowly moving into the positive zone. She is starting to fulfil my expectations. It is a very pleasant feeling, and I notice I start to smile at her again.

The change in strategy stopped the disturbances because expectations in my Teacher-Self were being met. It allowed energy to flow freely within this existing thinking frame, giving me a sense of balance. I found myself in a fitting Self. The classroom situation made sense to me again and I thus experienced 'energy from finishing' the conceptualising process. This led to a coagulation of energies in the emotion of pleasantness and manifested itself by smiling.

I decide I want to move further down the pleasant zone. I know I have to confront my fear: I will have to observe whether she is working. The danger is that if she is not, what will I do? I do not

want to get into that 'unpleasant' spiral again. I have got one big advantage: I can make a conscientious decision when I look at her. I do not have to do this if I do not want to or if I do not feel it is the right moment. I chose my moments to look. Good moments are when there are no other demands on me to do something, not from other students or myself. When I look, she is not always on task. Because I wish to move in the pleasant direction, I am aware that I have to stop seeing the general, i.e. Macy is not on task. I am starting to focus on detail, on the particular.

The finishing energy I experienced from conceptualising and the uninterrupted energy flow from finding myself in a fitting Self allowed me to act on the will to move to another zone. Having this objective, I experienced a new surge of 'energy from direction'.

One lesson, I notice Macy is trying to distract Samantha and that is not an easy job, because Samantha just works. And I focus on the techniques she is using to distract Samantha. On her body language, on her gestures. She tries to chat, leaning over to Samantha. Samantha says something back, I think to the extent of 'I am working', because Macy moves back sitting straight in her chair. She keeps looking at Samantha. She turns her body towards the window, as if something interesting is happening

outside. Samantha does not react. Macy turns back to sit straight. She must be really thinking about this. She has not noticed I have been looking at her the whole time. Some of the girls have noticed it and are looking at Macy as well. It is getting rather comical. Haha, Macy thinks of something else. She slowly moves her whole arm, not just her hand, over Samantha's exercise book. Bingo! Samantha looks at her and laughs. They chat together. Then Samantha notices the other students and I are watching. Macy looks up as well. I have to laugh. Macy turns red in the face and smiles with a grin. And she goes to work.

The other students participating in the situation by watching and laughing when I started laughing made me feel really good. I experienced a swell in 'energy from being part of a group' as it confirmed my 'correct' conceptualising, that is, the meaning I had given to the situation was mimicked and must therefore, at least to some extent, be plausible and valid.

I hope this elaboration on the example of Macy will give you an indication how I used the notion of energy dynamics in my teaching to identify underlying phenomena. How using my awareness of energy dynamics alerted me to underlying phenomena. How using my consciousness of energy dynamics guided me to become aware of my thinking, of the process of my making sense and how it allowed me to intervene in the automatic and

subconscious dynamics of my behaviour. Gattegno wrote about energy dynamics:

“Energy dynamics is what constitutes the reality of the awareness of awareness. Indeed, breaking through forms to reach energy is to leave content aside and entertain the awareness itself”

(Gattegno, 1987b, p45)

Similarly, I experienced energy dynamics as a manifestation of what happens in the process of my making sense. Being vulnerable and aware of these energy dynamics offered me a pragmatic metaphor, a real-ity, of my awareness of awareness. By thus using the notion of energy dynamics I have been able to identify and explore phenomena underlying my making sense process, and contemplate my awareness itself.

On phenomenology and the Discipline of Noticing

Something I only became aware of during the writing up stage of this thesis is that most of the authors I refer to developed their theories using phenomenological methodology. I could therefore potentially be missing other contradicting and critical points of view. My second critique to this thesis is: is my enquiry methodologically sound and are my conjectures

consequently valid?

Lakoff and Johnson criticized phenomenology and argued that phenomenological methodology needs to be supplemented by empirical research into the cognitive unconscious (Lakoff and Johnson, 1999, pp5, 12). I did not undertake this kind of research in this way. Apart from the issue of whether such critique of phenomenology is valid, the question remains whether such empirical research can be achieved by using theories from well respected authors and using examples from personal experiences to illustrate ideas and conjectures as I did. In a sense, this judgement can only be made by readers, based on the extent to which they found themselves resonating with triggered memories of personal incidents which are then informed and explicated by my theorising. A further test is whether their future actions are informed by freshly awakened sensitivities.

Gattegno addresses whether awareness and noticing, or ‘watchfulness’ as he also calls it, is as reliable as quantifiable methods. In one of his newsletters he writes:

“Watchfulness is a personal instrument more reliable in fundamental matters than recording instruments, since recordings don’t read themselves, and the watchful person both receives data

and looks at them with a searching and varying mind which is not part of physical instruments. In fact, every instrument is the objectivation [realising your ideas in something tangible] of a mental instrument whose awareness must precede the making of a physical one and objectify those selected awarenesses which are part of the study or investigation.”

(Gattegno, 1987a, p1)

I do subscribe to Gattegno’s reasoning that every ‘objective’ instrument is an ‘objectivation’ of a mental and ‘subjective’ concept, making the instrument ‘subjective’ in turn. However, I have questions about the extent of the ‘searching and varying’ that happens in the mind of the watchful person. As I argued in this thesis, making sense is a personal and individual process because it is based on looking for similarities and analogies in past experiences and these differ from person to person.

This leaves me with two concerns:

First, the issue of the subjectivity and maybe even randomness of the triggering of foci of attention which, in the end, determine the identification of phenomena. I found solace in Bruner’s argument that any research is subjective and in a sense opportunistic:

“Now obviously, research on anything will yield findings that mirror its procedures for observing or measuring. When we “confirm” our theory by “observations” we devise procedures that will favor the theory’s plausibility. Anyone who objects can poach on our theory by devising variants of our very own procedures to demonstrate exceptions and “disproofs””

(Bruner, 1990, p104)

I acknowledge that my research is in this sense subjective and to a certain extent opportunistic. But as I made clear from the beginning: what I am offering in this thesis is not THE truth. What I am offering is my articulation of the integrated sense I have made, in the expectation of affording possibilities for readers.

Second, phenomenological methodology and the Discipline of Noticing, subjective by nature in the sense that they are a reflection of some personal sense-making, raise the question of validity. Although a conjecture might seem valid to the reader, does this mean it is valid? Cronbach, who concerned himself with methodology in psychology, argues that validity comes from plausibility. He writes:

‘Validity is subjective rather than objective: the plausibility of the

conclusion is what counts. And plausibility, to twist a cliché, lies in the ear of the beholder'

(Cronbach, 1982, p1.08)

In Chapter 2, I argued similarly and stated that validation of my conjectures comes from the reader through identification and recognition of the examples with their own experiences, with their assessment of plausibility.

What next?

First of all, I will continue exploring and applying my findings in a pragmatic teaching environment and (hopefully) develop a scholarly model to observe and record this. I have effectively started this already as a consultant for a local authority, working with teachers on their professional development, incorporating many of the ideas I have developed in this thesis.

Second, as a long term project, I would like to compile a 'dictionary' with descriptions of different kinds of energies I encounter, including references to conjectures and findings of this thesis and incorporating new insights I have gained from my continued research in the classroom.

Third, I would like to explore the notion of ‘functionality’ further and develop a mathematical language to describe this.

Fourth, but not last on my wish list, is by building on the notions of *flow* and *jouissance* I would like to explore issues of passion and the creation of passion in the teaching and learning of mathematics. In my role as consultant I have started exploring this by asking teachers to identify a sense of aesthetic they can experience in each mathematical ‘topic’ with the aim of thus triggering ‘passion’ for teaching mathematics.

Reflections

In this thesis I worked on the understanding of the human mind. Probing my experiences, I developed a hypothesis about the meaning-making process and the construction of meaning.

By using the image of a journey on the River of Energy, I identified structures within experiences through the exploration of underlying phenomena. As a result, I offer a kind of structural phenomenology of the human mind, illustrated by accounts of my experiences offered in a metaphorical format.

In doing so, I feel I have represented a cross-section of my psyche, including

cognitive, affective, social and psychological aspects. At the same time, I offer an explanation of the *process* of finding a solution to classroom issues from learner and teacher.

Personally, this doctoral study and its findings have offered me an extra dimension to the quality of my life. I was able to dwell in my thinking, discovering theories and developing conjectures at my own pace and following my own interests while recognizing the importance of my subjective experiences. Csikszentmihalyi captures this beautifully:

“The actual quality of life – what we do, and how we feel about it – will be determined by our thoughts and emotions; by the interpretations given to chemical, biological, and social processes”

(Csikszentmihalyi, 1997, p4)

This has only been possible by the kind of support my supervisor has offered me, by his way of being. He let me discover and experience these discoveries, never instructing, only pointing. This allowed me to ask what I think are ‘good’ research questions. In this context I offer you a last quote:

“The most common prohibitive factor [for asking good questions

in research] is that we accept to be too dependent on pre-existing methods of work developed by people we do not know, never meet, and who are introduced to us as the highest authorities in the area in which we are interested. For example, at graduate schools in American universities, it is assumed that one has to read as much as possible of the literature on the subject and determine the state of the question – or rather its formulations – before one studies anything directly or one even contemplates entering into an examination of the matter on one’s own. Such studies of literature take a great deal of time. Students often find – mainly in human & social studies – conflicting, partial and unsystematic viewpoints, which reduce their confidence that they could make a valid contribution. Hence, students resort to tackling a small fragment of the challenge and to contribute very little, thus confirming the belief that in these sciences progress is slow or insignificant”

(Gattegno, 1985, p13)

I thank John Mason profoundly for supporting me in this.

By being allowed to ask my own questions, pursue my interests and follow up my awakenings I have shown how a phenomenological approach to exploring led me to act differently in new situations. By sharing these findings that

allowed me to develop and change to reacting more sensitively I can contribute to the knowledge base of both researchers and teachers community, and alert colleagues to the potential of

- The powerful effect of being sensitized to energies, to the ebb and flow of energies in the classroom and being able to manipulate these both within oneself and within students.
- The powerful effect of seeing a person as consisting of Multiple Selves each with its own behaviours, sensitivities, expectations and assumptions to explain and manipulate behaviour and thinking. For example, how the triggering of certain Selves can be influenced by the interpretation of the sequence of events (Jones, Bruner) and how humour (Bakhtin) can lead to a switching of Selves through manipulating the hierarchical characteristics that come with each Self.
- The powerful effect of using in mathematics education ideas, notions and theories coming from areas outside mathematics education. For example how using notions of such as metaphor and metonymy from cognitive linguistics (Jakobsen) and Reader Theory (Jauss and Iser) can help in the design and analysis of tasks that trigger Mathematical Thinking; how ideas from minimalism (LeWitt and Judd) and stage design in the theatre (Rotterdams Theatre) offer pragmatic insights in the creation of cognitive disturbances; how the notion of Bollas' *b-objects* from the discipline of psycho-analysis can offer a tool to

manipulate emotional states and energy dynamics in the classroom.

- The significance a phenomenological perspective offers to explore phenomena in mathematics education. My work underlines the power of the use of anecdotes and examples to illuminate and build on phenomena and frameworks. Another way of seeing the thesis is a way of making sense of making sense, using a phenomenological format of enquiry which can be used by others as a model to follow.

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