

## **Part 2 - My story**

### **The evolution of my teaching of physics**

## Epistemological Notes: April 2006

The classroom is my mirror, my playing field, the opportunity for my deep questions to be explored. Only now, towards the end of my research process, can I perhaps see that what informs all that I have been through is *my deep yearning for wholeness*. This yearning, when framed in terms of teaching and learning, yields questions like:

What does it mean to be a human being?

What is the purpose of education?

How can I help my students to learn, do, be, become?

What does it mean to be a holistic teacher?

What might Holistic Education look like?

How can I integrate soul in my teaching of science?

So now I must be both *scientist* (in exploring these questions) and *artist* (open to the creative expression of my understanding) and *listener* to what my relationships with others tell me. Perhaps then I might learn something. Perhaps then I might live my way into wholeness.

I share now with you this journey.

I am aiming to tease out some of the key concerns of Holistic Education... the concepts of wholeness, connection and being. Rather than exploring these philosophically, I have tried to live them... what do they mean in my science classroom? I am hoping that in the reflecting and sharing of these lived experiences, you and I will gain a *richer* understanding of what these might mean in

a practical educational sense and what might be implications for design of curriculum frameworks. I am not trying to provide a complete understanding, but just one perspective based on practical wisdom.

My story is also the story of evolving science teaching practice ... I am in the process of constructing *living educational theories* - these are contingent, being constantly perturbed, filling a need in me to understand what it is I am doing. Whitehead (1998) says that the meaning of such theories cannot be reduced to a set of interconnected propositions because the meaning lies in the living contradiction of the 'I'. And I am certainly a contradiction. The 'disorienting dilemma' that is fuelling my transformation of self and understanding, is the need to integrate my science self and my spiritual self. The pedagogical space of my Physics classroom enables me to explore these tensions for a period of 10 years - from 1990 to 1999.

And in the process of doing this I have found my way into conceptualising science and science teaching which includes soul. I have used Integral Theory as a framework in helping me articulate the different aspects of this. I am hoping that this living theory of mine might also resonate with others, beginning a dialogue where we might explore the implications for science teaching from K-university.

### **Action research and lived experience methodologies**

What processes of investigation did I use in exploring my own teaching practice from 1990 to 1999? Although I didn't start my doctorate formally until midway in this journey (1996), I was using a simple action research cycle of Kemmis and McTaggart (1982) (plan - act - reflect) when I started my teaching in a school which supported pedagogical experimentation. I was also engaged in lived

experience inquiry - creating living theories to explain what I was doing. According to Whitehead (1998):

The creation of living theories begins in practice. The creation begins in the kind of inquiries which I think you will have engaged in of the kind, "How do I do this better?" or "How can I help you to improve your learning?" or "How can I live my values more fully in what I am doing?"

In the process of answering such questions, the action researchers find it helpful to use professional learning or action/reflection cycles of:

- expressing concerns when values are not lived fully in practice;
- constructing action plans with details of the data to be collected to enable a judgement to be made on the effectiveness of the actions;
- acting and data gathering;
- evaluating in terms of understanding and the effectiveness of the actions;
- modifying concerns, plans and actions in the light of the evaluations.

When I first started this action research process my data gathering was based on conversations with my students, collection and interpretation of their work, observations of how they participated and engaged in class activities, and their comments about usefulness of activities and their own learning. I was able to be part of a rich dialogue of my emerging theories with my colleagues, engaged in peer observations and team teaching opportunities.

When I started my doctorate I moved to an *action inquiry* model based on Torbert (1991) which was based on deeply questioning one's assumptions - applying a 'critical subjectivity'. For example, in a simple action research approach one could ask "*How can I help students be better on tests?*" and then look for ways to do that. But using critical subjectivity one might ask "*Why am I valuing tests? What underpinning assumptions about education am I making?*" This suited me because underpinning my need to improve my practice was the big question "*What is*

*education really about?"* Asking questions about underpinning assumptions is a key in transformation to new perceptions, habits of mind and even perspectival levels (Mezirow 2000).

During this phase of my research (1996 -1999) I became much more rigorous in data collection - using interviews, questionnaires, learning environment surveys, a focus group with an outside interviewer, peer observation. I tried to create environments which enabled my students to give me honest and iterative feedback, checking the meaning I was making with them. I tested my emerging theories on my state-wide physics colleagues. I sought feedback from my students about the appropriateness of my tentative theories to their own learning experiences with varied results.

I kept journals which included lesson or topic ideas and plans, narratives or dialogues about what was happening in the classroom, my reflections, responses to my reading of theories and much theorising about how learning was taking place and where soul might be present. Cartoons, concepts maps, poetry, notes and stories.

I was keen to ensure triangulation in types of data collection as well as ensuring triangulation in perspectives of participants.

In 1999 I was co-ordinator to a collaborative action research project in a university physics department working with five lecturers to transform teaching practice. This enabled me to check my emerging theories in a collaborative setting with a large and rigorous data set of student and lecturer responses. It shifted my view of what I was doing from out of my classroom and into the bigger arena of science education transformation. So not only was I interested in exploring how to

improve science teaching for students, I was also interested in how to work with teachers in helping them transform their practice. And in doing so I opened myself to the greater issues of systemic transformation.

The validity of action research according Whitehead (1989) lies in whether the inquiry was carried out in a systematic way, whether there has been an inquiring and critical approach to the educational problem, whether assertions are clearly justified, whether the claimants have made clear what value judgements they are making as to what it is possible for them to claim, and that they have shown they have tried to critically accommodate their theories within the educational field of research.

I would also like to add another one - **praxis** - usefulness in helping me to be a more effective teacher, and usefulness for my state-wide colleagues in physics.

### **Auto-ethnography**

I have described above the actual research processes I used at the time in exploring my teaching practice. Now let us move to 2004-2006 - the period of writing about those experiences. This written study is situated primarily in the field of **auto-ethnography** (Ellis and Bochner 2000) and **writing as inquiry** (Richardson 2000) where I reflect on the journey I have taken as a science educator. In order to reveal the processes and the dilemmas of this journey I am using a **confessional style** (van Maanen 1988) with reflections based on my perspectives *at the time* and my perspectives *now*. I contextualize my writing of realist events by trying to be as open as I can about the assumptions and values that I might bringing, though these are changing.

For most of my storytelling I write as if I am present in the moment. I am projecting myself back into both the situation and who I was at the time. I try to relate my thinking and feelings. However, I have come a long way since then; memory changes and is reconstructed. I am in a different head space and soul space now. So how can I bring authenticity to this prose? Ellis and Bochner (2000) suggests that events that were significant to us, which involved emotion and learning are ones that we can still inhabit despite the distance of time. We begin to inhabit them by remembering our feelings, seeing the environment we were in until we find ourselves in this time capsule.

This is what I have tried to do in remembering and re-storying. I have chosen significant pedagogical moments for me that caused me to rethink who I was and what I believed. I am stringing together these moments to make a story which I hope has coherence. The story in a way is chronological, but I have also extracted some themes which overlap in time. At times I move into an impressionistic writing style (Taylor 2002) to capture the essence of a situation.

Within the story are several subplots:

- my own transformation and reconceptualisation of who I am as scientist, science teacher, educator, and spiritual being
- my development of effective pedagogies in the teaching of science
- my development of *living educational theories* which explain student learning
- my reconceptualisation of what science is
- my reconceptualisation of what spirituality is
- my reconceptualisation of how we see students and what education is really for

- my efforts to help transform teaching practice and my growing understanding of the issues of transformation.

These story threads and themes are constructed. I am making value decisions on what is significant and this is informed by my perspective and agenda at the time of writing. I am orchestrating the meaning to be found in this complex experience of mine with the result that too often I feel that I am over simplifying. I am balancing this with trying to include richness, trying to unpeel meaning and trying to maintain the interconnections. It is very difficult.

To help me, I have in mind Henderson and Kesson's (2004) seven modes of inquiry or ways of knowing. These are seven voices that they suggest we should bring to any inquiry into education. They are like parts of a holograph - each has aspects of the other - together they create a wholeness.

Yes, I am interested in any inquiry process which values wholeness. Perhaps ensuring I engage in each of these modes of inquiry might assist in my own journey towards wholeness. As I ask questions in this writing process,

### Seven Ways of Knowing

**Techne** – *craft reflection* – how do we do it?

**Poesis** – *soulful attunement of the creative process* – what is whole and beautiful in what we do?

**Praxis** – *critical inquiry* – what are the underlying power structures? Whose needs are being served?

**Dialogos** – *multi-perspectival inquiry* – different voices, enabling dialogue.

**Phronesis** – *practical, deliberate wisdom* - unpacking the reasons behind things.

**Polis** – *public moral inquiry* - what are the underpinning values and ethics?

**Theoria** – *contemplative wisdom* – what is the purpose of education, what does it mean to vision?

Henderson and Kesson (2004)

Fig 5.1

perhaps I can listen carefully to where they are coming from - which of these voices are asking this question - and perhaps then I can explore these questions with a bit more awareness and depth.

Now a few confessions...

This is my third attempt at writing this section. The first one was a major critique of why physics was not Holistic and why it was in a box, despite my efforts to be a holistic teacher. The second attempt oscillated in the other direction... I almost constructed a teaching manual (*how to teach holistically*) and was almost too self congratulatory as a counter response. I did these in 2005. This third attempt (2006) draws from both.

During my writing in 2005, I did a lot of reflection about my own experience as a scientist as well as a teacher of science, journalism, maths, and enrichment courses on spirituality, as facilitator of philosophy forums and my work with state-wide colleagues and the university action research project. Here was a rich source of material from which I could look at myself and my own transformation in a 20 year context. I began to see patterns. Then when I was introduced to the perspectival stages of Gordon (personal communication, 2005), something clicked. I could trace where I had been and wondered if many of my tensions were being caused by competing perspectives - I was trying to do something with my teaching because of the urge of my perspectival level, but science itself wasn't operating at that level. When I looked deeper at the collaborative action research project at the university I wondered then if some of the issues could be explained by spiral dynamics.

So an idea about how to integrate science and soul emerged and the more I wrote about my experiences the more I began to see how they might inform a way of thinking about Integral Science. My original aim was certainly not to do this - just to write about what it meant to try to be a holistic teacher in a physics classroom and to explore the resulting dilemmas.

So my purpose seemed to have changed as I was writing in 2005. I concluded with two chapters - one where I tried to integrate curriculum and soul, and another where I tried to integrate science and soul. Because this emerged from writing which did not have that purpose, the reader would be scratching their heads and saying, what is the purpose of this, where has this come from, you didn't tell me at the beginning! I was doing the emergent 'writing as inquiry' of Richardson (2000) where I was writing as I was thinking and gaining insight, and the reader was privy to those processes. But I had no thoughts of a reader as I was writing - it was really for myself and my own meaning making.

So now in 2006 I have gone back and tried to structure my writing so that it takes the reader on a journey to the conclusion. Unlike before, it has a much stronger chronological thread. I ended up writing far more than I expected and probably am including too much richness, given my now stated aim is to paint the shape of the environment. It is a difficult and iterative process in which I sometimes get lost.

It helped me early on in 2006 to see some grand themes in my practice towards being a holistic teacher which I have more or less stuck to in my writing. This streaming of experiences is constructed and ends up reconstructing my memory. In reality these themes - constructivism, meaning, questioning, significance, dialogue, ethics and enabling - were an interwoven part of my experience of teaching physics. Now that they have emerged as key threads I can go back and re-story my

experience in quick sound bites (see Chapter 2 introduction), but things were never that clear at the time.

So now I am bringing the 'critical subjectivity' of Torbert (1991) to my writing. I know I could write a different story of my experiences without the interpretive structures of Integral Theory and my themes - and in 2005 I did that. I am now concerned that my application of Integral Theory models to my experience might shape it too much, privileging some aspects while marginalizing others because they don't move the story along. I have to be vigilant that I am not ignoring disconfirming evidence. I try to look for it and include it. I still feel it is a bit of a Catch 22 when writing with a structure in mind, particularly when your interpretive structure becomes part of the solution.

However, even writing with such a structure in mind can be more than writing to get across certain 'endpoints' - as I am writing I am getting greater insight. I am wondering about the limitations and appropriateness of the models - I move from a naïve application of spiral dynamics to a more complex one. But it still is a simplifying device. But I tell myself that there is a role for demarcation and differentiation on the process of understanding the whole. In some cases I allow you to be party to my process of discovery, revealing *the process of writing* rather than the *endpoint* (Richardson 2000).

I have to be vigilant with myself in the process of writing not to be too self-congratulatory and therefore complacent every time I reach a new insight or perspective change. During this process I have had various conversations with others which might relate to the nitty gritty, the paradigm I am in, what I am trying to do and the meaning of words. For example, when a friend asked me "*What does feedback really mean to you Sue?*" I realized that my notion of

feedback might not necessarily be how other people see it and I need to explicate that.

These conversations have been critical in helping me clarify my own standpoints in relation to others, the significance of what I am trying to do and to see this thing called 'sue world' which is a construct of my own mind. I realize how much I had been in a cave in my first writing. Yes, I am a person who values feedback... I see it as a key way to test out ideas; through dialogue and seeing the effect of our actions (informed by these ideas) on others and the world. This feedback process is essential for growth and learning, yet in writing one can isolate oneself from this wonderful tool.

As I bring different lenses to what I am doing - whether it is applying an interpretive tool or asking the question "*How do I really know this?*" my standpoint is shifting. And I move in and out of feeling that what I am doing is useful versus that it is a futile exercise. The problem with too much self criticality is that it can be paralyzing. So I have chosen to plough ahead, recognizing a few of the epistemological pitfalls of what I am doing, and not really that pleased about them.

This type of writing has also helped me to come to understand my learning process in all this and realize that I am someone who is trying to include everything... an exercise which is problematic because of my temperament (which is prone to oscillation). When something new comes which does not fit or cannot be explained (no matter how small compared to this wholeness that I already have) it creates such a dissonance in me so that it seems everything is put into motion... a shifting of ideas, of self, and questioning my fundamental groundings. I am constantly in a state of transformation of one aspect or another, one level or another. And it is hard work.

However, this meta-cognitive process is helping me be a lot easier on myself. I begin to realize that I do have some foundations and as a result can now go back in and write with greater balance. I realize that there is wholeness at each stage of the journey, but here I have succumbed again to the seduction of greater understanding and wholeness waiting for me just over the next hill, despite my feeling that I had finished with all this processing last year.

In this process I am so much in my mind (which is constantly in doubt) that I forget that other aspects of myself, like my art, actually represent a very grounded spiritual view of reality. Now I begin to look to that to balance all this thinking I am doing. I am doing a piece right now of a reclining nude, naked to herself and the universe, with her surface peeling away. It is healing.

I have to remind myself to stop and give myself opportunity to enter another space and another way of being - to invite insight through meditation or incubation as suggested by Braud and Anderson (1998). There is also a playing out of the ideas in current events of my life and in reading fictional stories where I can interpret stories of others through the theories I am reading and constructing (which, according to Mezirow (2000) are important processes for someone experiencing transformation.) Yes, I need time to play with the ideas and let them sit.

So while *some* of my writing last year was what I called 'writing as therapy' I realize it was just the first stages.... The debriefing which included some analysis of the experiences. This next stage is enabling me an analysis of the processes and thinking which have shaped those experiences - another level up in perspectival awareness. So in my first round I was conducting an auto-ethnography (without

realizing it) where I examined the *education culture* which contextualized my experiences, now I am moving into examining the *culture of my mind*. I am getting closer to understanding self.

So this is a process of unpeeling many levels of different onions which interact with each other --- the educational culture onion, the spirituality onion, my personal onion, the science onion and the pedagogical onion. Too many tears from all this tearing apart? But tears are healing as well.

Here I am attempting to take the stance of compassionate observer, enabling myself to write with vulnerability and honesty. Am I coming totally clean? I am trying, but there are some things that even these attempts at self honesty are not able to penetrate. I also have to balance between divulging too much which is personal (for the sake of greater honesty, completeness, and cultural awareness) with the distractions that such self-deconstruction might take from the main story.

But I don't just stay as an observer; my writing moves in and out of 'present moments' and my current day perspectives, which at times might be indistinguishable. I am walking the tension of bringing too much analysis to an experience which could disrupt the continuing story with not enough analysis. I use epistemological pauses as breathing spaces to step out of the storying process as a possible solution to this dilemma.

Throughout this study I am describing students and teachers and making judgments about their behaviours; trying to apply my emerging theories to explaining what is happening. I am concerned about this as I don't like to judge others and am very wary that I might misrepresent who they are and even

denigrate them... an ethical tension. It is important then for the reader to keep in mind that these judgments are contingent and changing, and a necessary part of my process of coming to understand. I discuss some of the issues I have with this in my chapter on the Ethical Classroom (Ch 10).

To partly solve this, I have decided to use students' voice from their reflective journals as stand alones, without my interpretation, because in the wholeness of their voice there is a lot more to see than what I might extract and interpret. So now I hand over the ethical problem of judgment to you.

The student journal entries are unsolicited responses to what is happening in the classes and reflect what was memorable or significant for them. In contrast the focus groups, questionnaires and interviews are shaped by my own questions, needs and values. So these pieces of writing better represent the emergence of student understanding and being. I put them at the end of chapters so you, the reader, can apply the new insights from the chapter to your reading of them. As I read them from the place I am now, I see far more in them than I saw when I first read them. I am sure in another year's time I will see more. I invite you to go back and re-read them as you explore further chapters and note if you see new aspects within them.

Students only used these reflective journals in the last two years of my teaching but I have included some of their entries at earlier times in my chronological story because I think they represent the particular perspective I am trying to illustrate or challenge. You may well ask, how does what happens in my 'holistic classroom' in 1999 reflect what was going on in my 'constructivist classroom' of 1993? That is because I took the students on a journey similar to my own... starting with where they were at... which was a very pragmatic and authority based experience of

science (*how do you do it?, what do I need to know?*) ... so during the course of the year their type of entries change to reflect more holistic and existential explorations which I then incorporate into those later sections. Also, I am engaged in a process of *transcend and include* in my teaching, so pragmatic constructivism still forms an important aspect of my teaching of science which I was continuing to develop right up to 1999.

In doing this placement of student voice I had to let go my need for chronological accuracy and it took me some time to be comfortable with this seeming sleight of hand. It helped to reconceptualise myself in this writing process from scientist trying to '*represent the truth*' to an artist '*expressing essences*' where the criteria for validity now becomes *verisimilitude* (how well does it convey a sense of the real?) and *authenticity* (aims to develop the reader's understanding and appreciation of their own views).

I use these student reflections as a way of illustrating, expanding and providing dissonance to what I have said. Yes, I am using a Bateson (1972) technique in occasioning your learning experience but not trying to make everything clear, not making all the inferences that could be made (which are never 'all' and therefore can suck us into believing we know it 'all') and through offering you different ways to experience what I am saying... through student voice, fictitious dialogue and through my artwork.

I am using my experience as an artist in creating 'space between' and depth and layering to offer the potential for emergent understandings. And I hope that this experience of reading might also be something that reveals an aspect of what I mean about Holistic Education.

Is this writing an integral art form?

According to **emrgnc** (2006) Integral art holds that:

- all perspectives are valid,
- some viewpoints may transcend and include others
- where you stand is what you see.

Integral art includes both the experiences of artist and reader and each can bring many different eyes to it. Integral art may help in both transformation of the artist and the reader. It may be an expression of transpersonal knowing which pulls the reader into a deeper connection with their higher self.

I allow you to judge how it affects you. It has already helped in my own transformative understanding and enabled me to call forth my own higher self, or so I think.

As I am writing about my own experiences I am also thinking of implications of the development of my pedagogy and my transformative learning journey for those Tasmanian Year 11/12 curriculum planners that I introduced to you in the earlier chapters. I am sure that given the chance they would have a lot to talk about in terms of implications for curriculum design, how to think about subjects and learning as well as issues with the professional learning of teachers. I invite you, the reader, to ask these questions as you read about my experiences. Can you imagine how curriculum planners might respond? I give them a brief opportunity during an Intermission.

There are also many more threads emerging from my stories that I could take up and explore deeply. I am aware, with the benefit of hindsight, of the shortfalls in

my action research throughout 1996 to 1999. I was a pragmatic girl. My goal was clear... to trial as many different Holistic pedagogies and principles as possible. To get inside the notion of Holistic by covering as many aspects as I could and see how they are inter-related. So this is a key element of this journey - an exploration across a large territory with the interconnections becoming in a sense more important than the parts. After all Holistic is about wholeness and connection and in my very inquiry I was trying to live my way into experiencing that.

But still I keep wondering now, what I might have found out if I had asked a deeper question or from other perspectives. But I could only ask from the standpoint I was in and the perspectives I had. The very act of asking questions has enabled me to be in a place now where I can see what other questions I could be asking. And I am well aware that even here in this place there are many questions I still don't know exist. I need to learn to be comfortable with that sense of incompleteness and enjoy the journey of finding out, just as my students learnt to do. Otherwise there would be nothing to look forward to.

In 1997 I became very distraught after hearing a conference speaker talk about the importance of going deep. Rather than digging lots of shallow holes, we should dig one and then go deep into the heart of our own experience, she said. I thought perhaps that in all this trying to connect many different aspects I was digging lots of shallow holes and avoiding the depth. Was my whole life shallow? I am such a generalist, pulling skills and knowledge across many different areas, whether it is careers, relationships, within teaching, or my own spiritual life. Should I be on a path of exploring one thing deeply? Perhaps I am, but the topic is not wholeness, or connection or spiritual development.... Perhaps the topic is me. So what tools might I bring to exploring this one thing deeply? Mindfulness, honesty, integrity,

compassion, ability to helicopter in perspective? And in exploring this one thing can I *discover and live my way* into wholeness, connection and spirituality?

### **Ethical considerations**

My research can be considered in two stages - the **action research** stage and the **auto-ethnography** stage, each with its own ethical considerations.

*In being engaged in field research, how does the very act of research impact on those people that one might be researching? What is the responsibility of the researcher to the well being of the participants during the course of the research?*

My research of my physics classes was not that of an outsider coming into a classroom and getting data. Rather it was me, a practicing teacher, slowly changing my practice and ways of being and thinking as I tried to move towards being a holistic teacher. As a teacher, I already sought relationships with my students and encouraged honest feedback about my teaching. I had always experimented with teaching methods and in a sense all my students over the years had been inadvertent guinea pigs.

But now moving into action research I was explicit about this - asking my students for their permission to try new things on them and to participate more in giving me feedback through interviews and questionnaires. This process naturally impacted on my students. For many it was seemingly positive; feeling that they had a voice in their education processes as well as the development of self-reflective thinking and self-awareness.

The learning activities which I facilitated and the relationships I made also impacted on students, sometimes creating significant transformative moments for them. But how is this different to my role as a teacher whose aim is to foster student development and to support their sometimes messy transformations? In the process of doing such research I developed a greater sensitivity to my students' needs and voice, taking more ethical responsibility and developing a greater self capacity for care. It was a process which was not necessarily perfect but it was about growing into more ethical and mindful ways of being. I describe some key moments that helped my own transformation of perception in Chapters 9, 10 and 11.

Developing respect and care for my colleagues has taken longer. I describe the shift in my perceptions to my university teaching colleagues in Appendix 3 which gives some insight into the difficulty of developing humanity within oneself.

*So what is my responsibility now in writing about these experiences? How do I represent the participants in this inquiry? Can I accurately reflect their stories or their meaning perspectives? How can I check my interpretations and enable their voices to be heard? Should I allow for greater collaboration in compiling multiple perspectives (the *dialogos* of Henderson and Kesson, 2004)? Am I showing sufficient care for them in revealing their vulnerabilities?*

Certainly at the time of doing the field research I was keen to check my understandings with my students and refine my interpretations to more closely match their own interpretations. This was essential to my process of coming to know them and see them (an infinite well) so that I could perhaps dig deeper in myself to grow my own humanity. (I discuss this process more in *Appendix 1- Explicating my research process*).

But was I seeing **The Truth** (a single correct interpretation) or a **small truth** (a transient consensus)? In many cases it was a tentative seeing that enabled me to progress to deeper relationships with my students... a never-ending journey. At the time it held a certain amount of truth, or perhaps *praxis* would be the better word.

With the 'crisis of representation' in qualitative research (Taylor 2006), even member checking does not guarantee that **The Truth** can be revealed, nor that there is even one to be found.

Auto-ethnography addresses the crisis of representation by using critical self-reflexive inquiry. This research methodology recognizes that there is no one correct interpretation. The research area of concern is primarily a study of self in culture; it foregrounds the researcher's perceptions of the world as they interact with others. It is situated explicitly in the author's own interpretative perspective or worldview. Thus part of the process of inquiry is making these interpretive frameworks visible.

By bringing a critical lens to one's narrative, one is aiming for *verisimilitude* (making it seem real) while remaining aware of the dangers of claiming it *is* real. Thus one is asking oneself what other realities, perspectives or interpretations can be made. One is questioning one's own meaning making process and seeking to transform it. These questions enable the 'critical subjectivity' of Torbert (1991) which help to move one's current perspective into higher perspectival cognitive frameworks.

Thus in the process of writing narrative there can be several iterations whereby the stories are seen by the author from various interpretative standpoints; where

the author's unfolding and evolving worldviews are made transparent. Rather than collapsing this down to a single endpoint which privileges a particular interpretation, the author can use styles of writing (e.g. iterative stories, dialogue, dialectical reasoning (thesis to antithesis to synthesis)) which capture this process and enable plurality of meaning (*crystallization*). This can help the reader to also tread the tension of representation and interpretation; helping them to be more mindful of the situatedness of the author's interpretation with respect to the current state/stage of the author.

So auto-ethnography tries to be respectful of the participants in this way, rather than through the process of member-checking or multiple voice inquiry. Thus my responsibility is to be vigilant in this process - to be aware when I succumb to believing wholly in my own reality (and yes, it has happened a few times, but with help by my supervisor I was assisted in bringing new doubtfulness to my 'fixed' interpretations.)

So does this give me a license to make up stories about my students and other participants? I am trying not to, because although this is a self study I want to share with the reader deeper insights into the capacity and dilemmas of our students and the issues of transformation of science teaching. I want it to capture a sense of the real that can help create praxis in the reader - a self reflectivity and a desire to go find out for themselves. I want to provide *authenticity* (with the aim of developing the reader's understanding and appreciation of their own views) as well as *verisimilitude*.

Thus, I am trying to capture the essence of the experience *as I experienced it* or *as I now interpret* that experience. And this interpretation in hindsight now does not have the benefit of iterative checking with my students; it may seem quite

different to what they might remember of the experience this many years after the fact. So perhaps for some of the participants (both students and colleagues) they will feel these stories *are* made up or non-recognizable. They might not like how they are depicted in my interpretations. They might not like their vulnerabilities exposed. How will they feel in reading such stories?

There are so many stars and bit players now in this movie I have been making. Do I even try to check with them and ensure they are happy to be players with the lines I have given them? It just isn't feasible. So showing care for my participants is done by ensuring anonymity in my stories, through changing names and writing more impressionistically. Many of my students signed consent forms at the time (see Appendix 4) allowing me to use their focus group interviews and questionnaire responses in my study but I have not sought consent from the colleagues I talk about. Rather I rely on anonymity to protect their identities, or amalgamation of written characters.

I hope they can forgive me and just see what I write as saying more about myself and my interpretative world than who they are.

(But having just said that this research is based on my interpretative world then can I claim to know anything beyond that? Can I claim to have insights and recommendations which might inform science education? I would argue that the broader significance of my work is established by my links to the various research communities and through my addressing issues that they believe are significant.)

The other aspect of ethics in such an inquiry as this is one of **self-care** and this I have to say I was not very good at. I would recommend for anyone engaged in such critical self-reflective studies to make sure that you have a support team who

understand well the transformative process (spiritual, mental, emotional) and can monitor you and help you as you might open dangerous doors to the depths of being. Having a meta-understanding of the transformative process as well as a range of techniques to 'see' and interpret what is going on in multiple ways is also very helpful. These meta-understandings were something that I have only really gained as a result of my journey.

### **Where shall I start in relating 'my story'?**

I shall start at the very beginning in 1990; my first year of teaching year 12 physics. So the first theme is **The Constructivist Classroom** (Chapter 5) and then that moves through *The Meaningful Classroom*, *The Questioning Classroom*, *The Significant Classroom*, *The Dialogical Classroom*, *The Ethical Classroom* and *The Enabling Classroom*.

Each chapter represents part of my teaching journey which roughly relates to moving through different memes of the spiral dynamic model. So from a Spiral Dynamic (Beck and Cowan 1996) point of view, *The Constructivist Classroom* starts in the **blue meme** of *teaching science by authority* and moves towards the **orange meme** which values *student autonomy in thinking*.

For many students entering college and university the **blue meme** is their experience and expectation of science.... And for many university science lecturers this is their expectation of *teaching science*, even though as scientists they might operate within an **orange meme** scientific culture. (see Appendix 3) So this first chapter of my journey aims to start at a place with which readers might identify - as something that is still current in their experience, or something they might remember but have moved on from.

Does bringing in Holistic perspectives help movement towards the **green meme** in teaching science? What are the implications for student growth? What might push science further? I explore these questions in the subsequent chapters, finding ways to flourish physics and students' experiences of physics. But I come to a point where I have taken physics as far as I can go within the current educational system. So I need to look towards integral solutions. If you want to see the result of this journey and its implications for science teaching as a whole go to Part 3, chapter 12 .

In going back in time and relating these different stages my writing as inquiry voice has also taken on these different paradigms... starting with a more modernist propositional tone (seeking answers, generalisability and methods) in Chapter 5 and gradually moving to a postmodernist tone (dialectical reasoning, not reducing complexity to single answers).

This labeling using spiral dynamics is just a construct but perhaps by using such differentiation it might yield useful insights which we can then integrate in new ways.

I now invite you to come with me on this journey...



*Unpeeling the layers*

## **Prelude: some musings about why it may be important to reconceptualise how we teach science**

### **Exhibit A**

**August 2005**

I have been reflecting a lot about my own experiences as a scientist in order to help me understand what might be missing in our high school and university science courses.

Flashback...

*1984. I am a scientist in a paper mill and I am really happy. Karen, my work colleague, and myself have just improved the efficiency of the mill by 30% during the winter months and the mill is now earning millions more, and jobs are saved as the mill can now compete with the cheap imports from Finland.*

*1987. I am working as an economic researcher for the Tasmanian government researching the economics of the Australian pulp and paper industry. I discover that as a result of that increased efficiency, the paper mill now has more paper than the current Australian market can take, so it sells it cheaply in Indonesia. The old inefficient paper mills in Indonesia can't keep up and so they squeeze their wood suppliers to reduce the costs of wood. The wood suppliers have to cut down more trees to make as much money, sending woodchips to Japan. The destruction of the Indonesian native forests increases.*

Was it my fault? Should I have known? I decide to go over to Karen's place and discuss what I have remembered. I want to ask her what she thinks. She has continued to work in the paper industry and has been a researcher and lecturer at our university chemistry department for 18 years.

She is cutting up vegetables with her 10 year old son, Glen, in the kitchen. I tell her my story, piece by piece until finally I proclaim "So, I am responsible for the devastation of the Indonesian rainforests!" Glen is listening goggled eyed. "Is that all true? It really happened?" he asks. "Yes," I say, "that is the problem with doing science if you don't know the bigger picture and the impact of what you are doing."

“But Sue,” says Karen really concerned that I am blaming myself “You couldn’t have known at the time, you can’t expect scientists to know stuff like that! And anyway, if you were to blame so was I.”

“Yes,” I quip, “It was your fault too.... **AND...WHAT IS WORSE** ... you are still doing it!” She just looks at me, eyes wide open. “Am I? I never thought about it in that way.” She shakes her head... but now Glen wants to tease it out... “So being a scientist is a lot more than just learning science at school, you have to know about world issues as well?” He nods wisely. “I think that is really important. It is like playing SimCity... you have to know how one thing you do affects everything else.”

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Karen and I have recently spent quite a bit of time together. She has just started an innovative unit for 3<sup>rd</sup> year university chemistry students which uses *Problem Based Learning* instead of the normal chalk and talk lecture format of her colleagues. It has been very difficult and she has found a similar resistance from the majority of students that we came across in the first year physics project. I have been acting as critical friend, debriefer, observer of classes, interviewer of students. We are beginning to realize how prevalent cultures work to resist innovation in teaching; in departmental structures and requirements, in students’ past experience and expectations.

We are both shocked when students in interviews reveal the following conceptions of science:

Chemistry formulae are carved in stone. Therefore they are best learnt from a blackboard in a lecture.

My aim in my undergraduate degree is to get as much information as possible so that when I am working in industry I can just access what I need to know. I will have plenty of time to solve problems then. By doing a unit like this I am might be missing out on an important piece of information I might need for later.

I don’t need to learn how to work effectively in groups, I have been doing that for the last three years at university and I should know how to do it by now.

*(from someone whose group interactions were woeful based on my observations)*

Expecting us to come up with new ideas when we are at university is unrealistic. If we were working in industry there would be older people who could tell us how to go about solving the problem.

However, about one third of the class did get a lot out of the collaborative inquiry mode of learning; they came up with some innovative approaches, drawing on their expertise from other subjects as well as from what they learnt about surface chemistry in the unit. They find themselves moving from the bottom percentile of students in the course to the top. One student who is excellent at doing exams (through memory and regurgitation) now finds himself failing the unit as it is clear he cannot integrate information nor understand what bits are significant or not. He gives Karen major headaches as he protests to the department about his grades until she is forced to pass him.

Into whose hands would you like to put the future of the world?

## Exhibit B

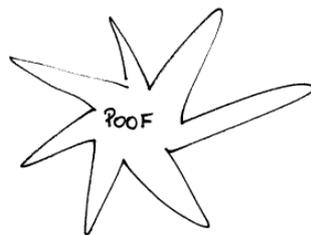


Fig 5.2

## Exhibit C: A quick quiz

Rank in order of importance what you think might be important in educating students to be scientists within each of the following subcategories:

1.

- being able to use an objective empirical method
- having technical skills
- being able to move in and out of 'scientific thinking' to explore a problem
- understanding the limitations of a scientific eye to solving problems

2.

- having a good foundation of disciplinary information
- knowing what you don't know
- knowing how to get information
- system thinker

3.

- being an expert in your area
- effective dialogue with colleagues within your area
- effective dialogue across disciplines
- Understanding the role your discipline has in the greater field of human endeavour

4.

- Able to take on the perspectives of others
- Looks for and is able to see the repercussions of what you do
- Aware of the culture you are in which dictates what you see
- Have an altruistic and caring attitude towards others and the planet

In what way might a quiz like this close down thinking or open it up? What would you want to add? How might you reconceptualise it differently?