

A report from the world CONASTA / ICASE / ASERA Science Education Conferences, Perth, WA, July 2007

Sustainability
Multiple Intelligences
Nature of Science
Indigenous perspectives
SymbioticA – where biology meets art
Reclaiming our cultures
Integrating science and soul



Where is science education heading?

A crisis in Science Education?

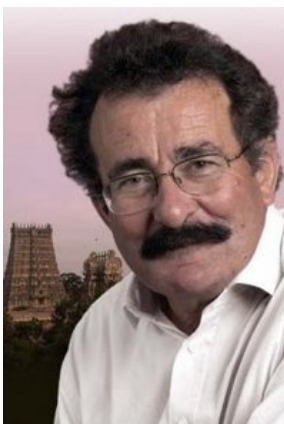
A key concern of all the introductory speakers at the conference was the decline in numbers of students enrolling in science and maths and continuing with science related degrees.

Suggestions were made why this was occurring and what could be done, including engaging students better. A Perth Declaration was made to provide recommendations for government responses.

www.worldste2007.asn.au/



Do scientists give science a bad name?



Lord Robert Winston is known by many as the face of several BBC documentaries (The Secret Life of Twins, The Human Body, Walking with Cavemen etc.) but he is also a geneticist who led the first team who created the IVF procedures that we use today.

As part of his keynote address, Lord Robert Winston highlighted the decline of scientific literacy in the community, saying that much time has been spent in the UK on emotional debate about issues such as GM crops, nuclear power, global warming, embryo/stem cells, Foot and Mouth Disease. He said that there is a failure of public engagement and misconceptions about the science leading to public decision making which is “non-scientific”.

Do Scientists give science a bad name? - Lord Winston (cont)

Having worked on a number of UK education panels Lord Winston suggested several reasons for the decline in numbers of maths and science students – eg. poor school laboratories, the point systems for tertiary entrance which made it more attractive for students to take the easier non-science subjects, declining numbers of specialised maths/science teachers.

“The crisis for science is one of community perception.”



However, he believes a key cause of poor community perception are the very scientists themselves who were giving science a bad name. As a geneticist he is very concerned about the over claiming that is being made by many scientists as a result of sequencing the human genome – he calls it “genetic astrology”. In contrast, epigenetics challenges the gene-only notion of hereditary or evolution.

He is concerned that both scientists and the public have a notion of “scientific certainty”. “But”, he says, “science is grey, it is interpreted. We need to change the culture in which we do science. The issue is not so much how the public think, but how scientists think. They should not exaggerate the importance of their work.”

Lord Winston has some clear recommendations for universities:

- Need more dialogue – explicit teaching of communication skills to undergraduates
- Scientists need to have a sensitivity to other perspectives and ways of knowing – not just value scientific thinking
- Understand the nature of science and its limitations
- Beware of certainty and exaggeration
- Ethical understanding – explicit courses on ethics and ethical decision making.
- Reinforce public ownership of science
- Recognize commercial exploitation

What might be the implications for Tasmanian Science K-12? Eg. Is ethics still part of the picture?

What is scientific literacy?

Jack Holbrook (ICASE) asks what is scientific literacy – is it public understanding of science or is it about responsible citizenship?

“We should distinguish between the nature of science education and science itself.

Industrialists are no longer valuing knowledge - rather initiative, ingenuity and critical thinking. So is science education about developing big ideas or about development of the individual? In what way is science part of education?”



How are notions of citizenship articulated into the new Tasmanian Science Curriculum?

Two approaches to science education?



Professor Peter Fensham (OECD PISA project) believes there are two conflicting paradigms of science education.

One is responsive to work – creating a knowledge society where information is the currency of the economy. Here “knowledge” is more a verb rather than a noun. Science is about knowing how to learn and think and work in teams.

The other is based on how education prepares students for life in the 21st C. It is about building scientific competencies and literacies. Having a knowledge of and **about** science – how science works, how scientists think and how science communicates. It is about empowering learning for action.

Are these really conflicting? Are there other paradigms we should be considering as well? What paradigms are present in the current Tasmanian Science Curriculum?

Breach the walls of science!



Professor Cliff Malcolm worked in South Africa as a science teacher educator and learned first hand the issues of applying a model of Western Science Education inappropriately in communities coming from rich cultural backgrounds with specific local issues. He challenges us to break down the walls of science education – broaden our notions of what it can be to include health, the environment, art and culture. “We need to find science contexts relevant to where schools are. There needs to be a balance between universal content and local content.”

He was also very concerned about the power imbalances which science creates. “Science is about power, wealth distribution – when do we talk about that in our science classrooms?”

Students creating science?

Dr Trevor Davies of the University of Reading believes that science education needs to be inclusive of creativity, relationships and citizenship. “We need to include values and emotions as well as cognition and intellect. We need to challenge the notion of elite scientists where students can’t create science or students can’t contribute towards the curriculum.”

Meanwhile Mike Driver, an ex-UK school inspector, believes that students can be turned onto science if we allow room for spirituality and soul. By this he means stimulating a sense of wonder and creativity, and enabling self-expression. He has a range of activities which he has been trialing in schools which have been successful in igniting students’ imaginations as well as their sense of connection to the amazing world we live in.

Broadening our concept of Sustainability

A key theme of the conferences was sustainability. Here are a few snapshots from different talks.

Learning for sustainability



Paul Perkins, Chairman of the National Environmental Council, says that we have moved on from first generation sustainability. This was value driven by people at a grassroots level.

Now we are moving into second generation sustainability which needs to integrate ecology, people and science. Learning for sustainability requires learning about uncertainty, creating partnerships and action learning in iterative cycles. If we don't do this we are stuck in the problem.

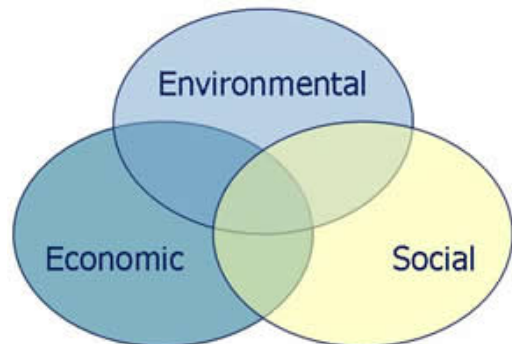
The Triple Bottom Line

Kerry Lee of the University of Auckland discussed New Zealand's commitment to the triple bottom line following from 1987 WCED "Our common future" and the 1992 Earth Summit. Sustainability is now considered in terms of economic, environmental and social sustainabilities.

Kerry described how a number of NZ firms have taken on board the triple bottom line philosophy in ensuring they meet staff, community and environmental needs as well as profit.

However determining the impacts of actions is not that easy – one needs to understand who all the stakeholders are and how they might be affected. "Stakeholders is a key term in NZ curriculum, but it is often misunderstood and confused with *shareholders*." So a key part of educating students is to help them tease out all those people who might be impacted in some way – the users, those engaged in the developing process – who affect the product, as well as those affected by the development or the product.

Students are encouraged to understand stakeholders contexts, values and behaviours before deciding positive or negative impacts.



"Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs."

How we talk about sustainability

Debbie Heck of Griffith University Queensland analysed the documents associated with the Queensland Environmentally Sustainable Schools Initiative (QESSI) to see how “sustainability” is being conceptualised and used. It sounds very academic but it actually revealed some useful insights. She came up with three different levels or ways that sustainability education is being conceived:

1. **environmental management and interpretation** – training of people, efficiency, effectiveness, restoration projects
2. **environmental action and community problem solving** – harmony, ethics, values, emancipatory at local level
3. **community change and emancipation** – eco-justice, culture, nature, inter-dependencies, non-linear, diversity, emancipatory globally and for the earth.



The Tasmanian Science Curriculum values students’ development of sustainable decision making and responsible action. What do we really mean by this? Should our curriculum ensure we are enabling development of all three levels?



Personal Sustainability

We might think of personal sustainability as the ways we can bring sustainable practices or thinking within our own personal lifestyles, but to a group of PhD students from third world countries using auto-ethnography to explore the friction between Western Modern Science and their indigenous ways of knowing and being, personal sustainability has meant a whole lot more.

Alberto Cupane, a Science Teacher Educator in Mozambique, described how the colonisation by the Portuguese of his country required students to learn Portuguese in school. Thus the language of science was in Portuguese while the home language was indigenous. Science was disconnected from the people’s daily lives and contexts – students learning knowledge for an industrial world while living in an agrarian one.

In exploring alienating moments of his own education through storying, Cupane has been able to see his own identity in new ways... finding ways to heal and integrate his fractured selves. Through gaining this “personal sustainability” he is now able to move beyond the box of Western Science and the box of his own indigenous culture to find ways to create a sustainable educational approach for his own student teachers. It is not just a matter of using contexts from his own culture in his science teaching – first had to come a whole new way of perceiving who he was as a person, as someone within a culture, as a science teacher and someone who was moving between the two.

Personal sustainability is then about addressing conflicts with **self – other – culture** and through this process being engaged in personal transformation.

“Scientific literacy needs to be expanded to include knowledge of self, how we do things and how we think.”



Multiple Intelligences – the past, present and future

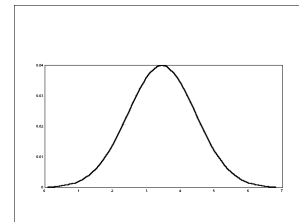
Keynote address by Howard Gardner, neuro-psychologist

Multiple Intelligences Theory is no stranger to Tasmanian teachers, with many of us using pedagogy that speaks to the different intelligences as well as fostering their development. The *Teaching for Understanding* program is a direct consequence of Howard Gardner’s work. So what more is there to know?

Howard Gardner gave a highly coherent talk which was a timely reminder of how we might have come so far, but still have a way to go.

Remember those days of IQ testing? He reminded us what started it. In 1900 Alfred Bernais was asked to come up with a test that could predict a student’s likely success or failure at school, despite a student’s previous school grades being better at predicting this! After 100 years, the thinking which underpins such IQ tests hasn’t changed and we can see it colonising national maths/literacy/science testing now. Yet cognition is much more complex and tests are not the best way to understand student ability.

The bell curve captures an orthodox Western view about intelligence – it is a single intelligence, highly heritable, not much you can do, and you can tell how “smart” you are by a single test. Compare with the East Asian view that intelligence lies in *effort*, not *genes*.



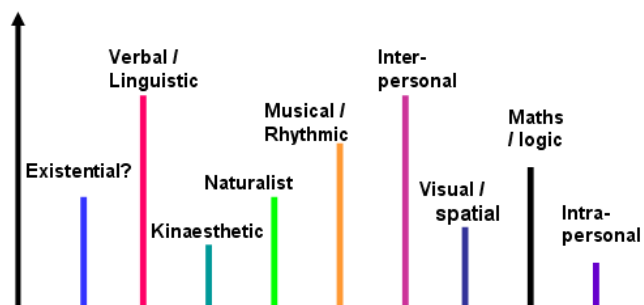
An intelligence is the bio-psychological potential to process information, to solve problems and make products

So enter Multiple Intelligence (MI) Theory:

- Based on evolutionary evidence and information about brain organization
- Based on examination of unusual populations (eg. Prodigies, autistic individuals)
- Recognition of different roles and “end states” across cultures and historically
- Deliberately inter-disciplinary and beyond sensory modalities
- Set of 8 specific criteria to determine an intelligence with specific cortex regions being identifiable for the different intelligences.

Gardner said that despite a greater awareness in education about MI theory schools hadn’t changed that much – “we are still providing uniform schools which teach the same thing, in the same way, and assess in the same way. Maths/logic and linguistic intelligences are still favoured in testing and this serves to create lawyers while marginalising everyone else.” He said we needed an individual-centred curriculum where we find out as much as possible about students, assess their strengths, match students with curriculum pedagogy and provide each student with a personal computer (an infinitely patient enabler).

However, he warned that MI should not be seen as an educational aim in itself... an end could be *teaching for understanding* –



illuminate something unfamiliar by drawing on skills, knowledge and thinking. “However, when we see kids who are poor in a particular MI we should help them strengthen it. As teachers, we should be ready to use multiple representations which draw on MI. If we can only teach in one way, it is an indication that we don’t understand it well enough ourselves.”

“And these are intelligences for what? It is how we use them... for good work. It is more than excellence in technical quality – it needs to be meaningful and ethically carried out. Character is more important than intellect.”

Research that Gardner is currently doing is looking at how intelligences are affected by aging – they become more internalised and personalised mental representations become more differentiated. In the future he believes that geneticists might look at whether there are specific genes for intelligences, and neuro-scientists might look at how people can be diagnosed early on based on brain profiles. “Will we be able to alter brain development?” he asked. Apparently he and Lord Winston had considerable arguments about these thoughts over dinner!

Debunking some Myths about MI theory:

1. Intelligence is not the same as sensory system (eg. Auditory, visual, touch) – each intelligence works independently of sensory system, while using them.
2. Intelligence is not the same as a learning style. Eg. Intelligence has development levels.
3. Intelligence is not the same as a domain or discipline. Mastering any domain might require several intelligences.
4. There is no official MI approach.
5. Intelligences are not God-given talents that can’t be changed.

Exemplars of education using MI:

Project Spectrum – a children’s museum which provides a rich learning environment. Researchers are able to observe how students use their minds within contexts that engage different intelligences. www.pz.harvard.edu/Research/Spectrum.htm



Reggio Emilia Schools – pre-schools – 3 to 6 years. Provide rich aesthetic environments which support student creativity, inquiry, wonder - carefully marrying light, colour, architecture and found objects. Teachers are researchers, undertaking a journey of listening to, understanding and enabling the “100 languages of children.” It uses just-in-time teaching and student led activities and is based on a philosophy which sees the child

as competent, able to make sense of the world in their own languages.

www.learningmaterialswork.com/shop/reggio.html

Note: In July 2007 an exhibition of the Reggio Emilia schools was held at the Long Gallery in Hobart www.reaie.org.au. For those who missed out it provided displays which not only showed products of student work but also the processes and the conversations they had as they were doing it. Students act as scientists, inquiring and hypothesising about the phenomena they are exploring, guided by teachers’ questions. The environment is also a teacher, deliberately designed to stimulate new perspectives – eg the notion of transparency and shadows can challenge students to think in new and creative ways about ideas they might have.

There is a Tasmanian group of teachers interested in Reggio philosophies who welcome new members:

www.tasresearchnetwork.com.au. Examples of schools incorporating Reggio principles are Friends pre-school and Illawara Primary.

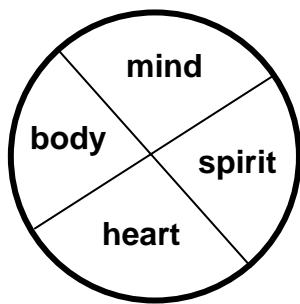


Integrating indigenous ways of knowing in Western Science Education

Dr Ali Sammel, education lecturer at Griffith University, described an interesting project she facilitated in a province in Canada. There was a concern that Western Science marginalised and alienated indigenous people, perpetuating an undesirable power dynamic. So over 18 months she facilitated a group comprising educators, parents, students and indigenous leaders to explore what a science curriculum might look like if it took into account indigenous perspectives.

Much of the indigenous craft wisdom had been lost, but what remained was a way of knowing and being in the world. So rather than indigenous perspectives being seen as content, it has been conceptualised as a way of knowing. Western Science just teaches “mind” whereas an indigenous approach also includes heart, body and spirit.

“Western science has decapitated the human being – educating to the mind only.”



Ali showed some examples of the teaching materials which use the four quadrants of the medicine wheel each representing body, heart, mind and spirit. Teachers are asked to use all four quadrants when exploring a phenomena or an issue. Not only does it bring other dimensions to understanding the world but it also builds self awareness and understanding – creating a more holistic approach.

SymbioticA – where biology meets art

SymbioticA (www.symbiotica.uwa.edu.au/) is an internationally acclaimed collaboration between scientists at the **School of Human Biology and Anatomy** at the University of Western Australia and artists from around the world who undertake residencies at the School. This is not a program of artists creating nice pictures of the magical worlds under the microscope. These are artists who are pushing ethical boundaries as they create art from the very constituents of life. One exhibit was a series of “pigs wings” grown out of the artists own cells.



Mentored by post-doc biologists, the artists learn tissue culture techniques, creating installations which challenge our notions of consciousness, life, and evolution. Does a cell have consciousness? At what point can we say life has consciousness?

Oran Catts, the artistic director, says that funding has constrained biological research into quite tight outcomes - the pure science that scientists used to do is no longer possible. Scientists don't have the luxury to just play and see what emerges. But the artists can - that is their job - to play. Not necessarily to play in the sense that a scientist might play - which results in innovation - but to play with the meaning of what the scientists are doing. As a result it helps the scientists see the possibilities and the consequences of where their research might be leading. It adds a cultural awareness, an extra perception.

Full story: www.sciencesoul.blogspot.com/

Reclaiming our cultures and paradigms of science

Presented by Dr Sue Stack

I have been working with science lecturers and teachers in assisting them transforming their practice using action research and transformative learning theory. To make a shift in pedagogy often requires a very big shift in the way a person conceives of themselves as a teacher - how they perceive their discipline, their students and the learning process. The habits of thinking and doing that have accumulated over time can act as barriers to change requiring a willingness to take risks and develop self-awareness and criticality. The change process can be quite frustrating; it can throw up conflicting evidence, often delves into the personal and needs to be nurtured with compassion.

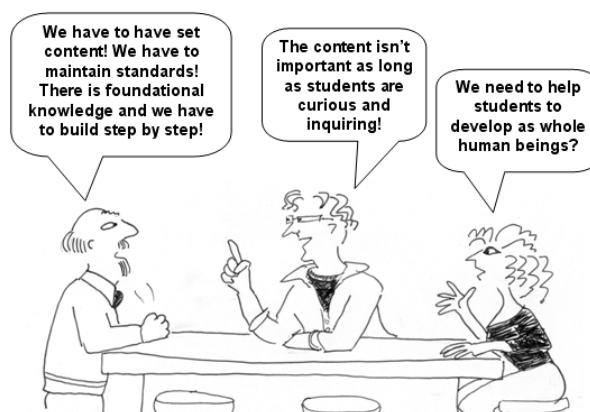
“ Changing teaching practice may mean moving to new paradigms and letting go of closely held assumptions.”

But we are in times where change is being demanded of us. We have new pedagogies which require new thinking, new identities and in fact new paradigms. And the problem with moving to a new paradigm is that it often marginalises all the others. Or to make things worse we might have a misalignment between our educational values, our pedagogy and our assessment. They may all be coming from different paradigms creating great confusion and stress. So can it help us to make these different paradigms explicit so we can understand where our thinking might come from? What might each paradigm have to offer in the way of an integral curriculum and what might we have to let go of in the process?

What are the different voices that we are hearing in the science education debate? Imagine some fictional characters (which have been dangerously stereotyped and only partially explicated)....



Gerald Blue sees science as a body of foundational knowledge – content which needs to be sequentially developed. He is keen to maintain disciplines and academic rigour and is concerned about declining standards. Assessment is based on exams with right answers, ranking and bell curves.

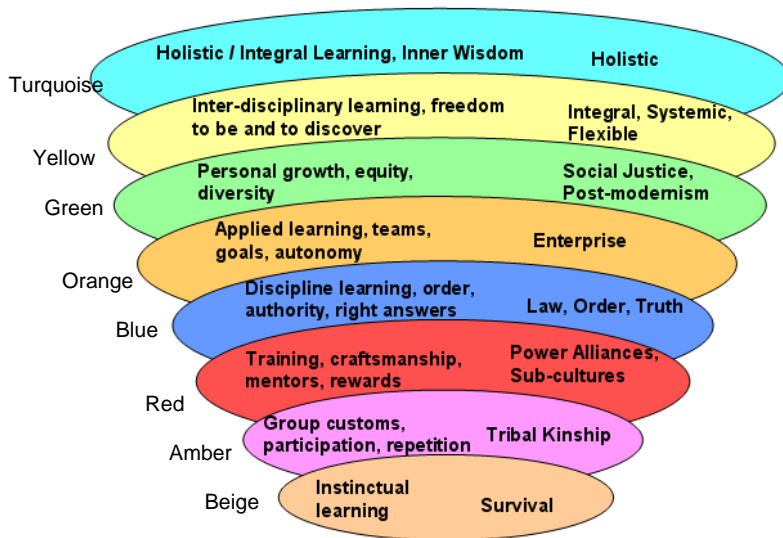


Pete Orange sees science as developing scientific literacy. He likes to create open ended situations to foster student curiosity, inquiry, creativity and ingenuity, modelling how science is actually done. He sees disciplines as artificial constructs which get in the way of examining “real” problems which are multi-disciplinary. Assessment is based on meeting key competency standards against learning outcomes.



Jenny Green is concerned with development of the whole child and she is interested in the aspects of science which support this. She is particularly concerned with the way Western Scientific thinking has marginalised other cultures and explicitly teaches the nature of science and other ways of knowing. She uses multiple intelligences and learning styles as key aspects of her pedagogy. Assessment is more descriptive, describing what the student has achieved and who they are – eg. folios, student reflections.

If we asked them to collaborate to design a unit of curriculum – eg. a Climate Change unit -what might their conversation sound like? Are their approaches and philosophies poles apart? Or are there some elements from each which together could build strong curriculum and pedagogy?

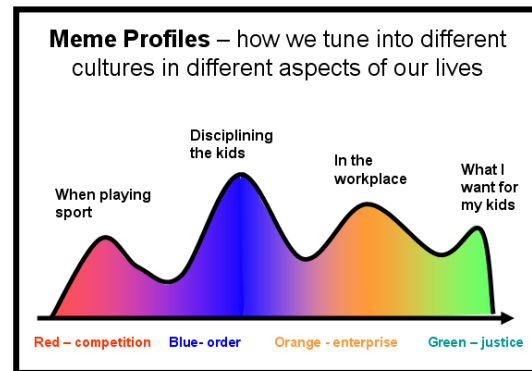


A theory that I have found quite useful because of its explanatory power in a number of situations (from world politics to science education) is that of **Spiral Dynamics** by Beck and Cowan. It is based on the work of Clare Graves who looked at how different civilizations seem to move through particular stages related to **value memes** – or cultural paradigms.

You will notice the similarity with Maslow’s needs hierarchy. As a culture moves to a new stage that stage will often squeeze out other

ways of knowing and valuing as people explore the new phase. Then a period of integration follows as aspects of previous cultures/stages are now re-examined and integrated from new perspectives and understandings. So the model is a holarchy – including and transcending in an evolutionary process. Each stage can have perceived positive and negative elements.

People can tune into particular cultural memes for different aspects of their lives. What is ironic is that while parents may want green meme values for their kids in terms of opportunity and developing character, when it comes to assessment they might want class comparisons coming from a blue meme, while they themselves might be assessed at work based on an orange meme of meeting personal and corporate goals.



But now back to Gerald Blue, Pete Orange and Jenny Green who you can see tie into specific unintegrated meme levels. How might Gerald and Pete resolve their differences about disciplines? Can Pete be more explicit to his students about ideas and knowledge of the different disciplines that they might be drawing on? But what ideas and knowledge? How does Gerald Blue see his discipline? Does he have a sense of what the big ideas are, what particular lenses the discipline is using that are different to other disciplines? Or does he see his discipline as a container of fixed bits of knowledge, “truths” or specific process skills? While he might “know” science is tentative, he may not be teaching it.

Perhaps the bridge between Pete and Gerald is in coming to grips with the nature of science and the nature of different disciplines. Perhaps Gerald can start thinking of inquiry not as a blackhole of possibilities which takes us away from discipline learning, but rather as inquiring into the discipline’s ways of knowing and seeing the world. Jenny is concerned that scientific inquiry marginalises other forms of understanding the world and is wanting to challenge the notion of “dispassionate objectivity” that Pete has about scientific inquiry. Can the three of them together envisage a much larger view of what we mean by inquiry and what constitutes rigour?

Now Pete, Jenny and Gerald represent (partially) only three cultural memes on the spiral. What about the other memes? Have we lost them in our thinking about science and do we need to reclaim them, allowing them to be part of the conversation? Perhaps an integral curriculum needs to encourage dialogue between the different meme cultures, encourage people to challenge underpinning assumptions and their identification with just one meme as well as assisting in transformation and integration of both the system and individuals.

Integrating science and soul in education

Presented by Dr Sue Stack

Most of us would say that soul in our science classrooms can be seen in the light in the students' eyes, in their sense of wonder, their creativity or in the special relationships that we have with each other. Allowing soul in our classrooms gives greater meaning and richness to experience.

I have been very interested in exploring how we can be more deliberate in the ways we bring soul into our classrooms and believe that there are two key approaches. One is a systemic approach for creating whole

school curriculum which draws on understanding how our body/mind/spirit systems develop in healthy ways enabling wise, balanced and connected citizens - seen in Steiner education and the Navajo education system. The other approach is based on infusing the "thinking curriculum" with soul and through this process learning more about ourselves and our students.

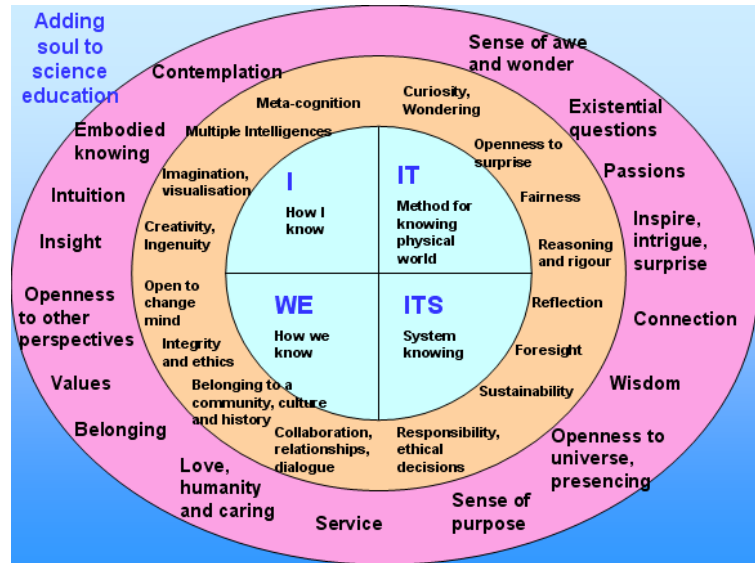
If the second option is the more practical one for now, where do we start? I found it very useful to look deeper into exploring *what science is* and its limitations as well as exploring key themes of spirituality in education. There are aspects of science education which can speak directly to a students development stage and when balanced with other ways of knowing can provide rich pathways into exploring the world and self.

Drawing from my own experiences of infusing the curriculum with soul and from the work of child development theorists I have mapped how science education can actually stimulate and assist various development lines and stages. It is important that aesthetics, care and sense of connection and place are considered part of the science curriculum – helping to develop “a warm heart as well as a clear mind”, which are the basis of wise ethical judgements according to the Dalai Lama.



Narrated Presentation:

<http://sciencesoul.blogspot.com/2007/06/integrating-science-and-soul.html>



This report has been compiled by teacher and researcher, Dr Sue Stack.

Available for:

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