

Holding the Tension of Opposites

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Although this article is set in terms of mathematical education in South Africa, I assume that readers will find parallels in other countries. At the time of writing (November 1992) the South African education system still consists of nineteen different Education Departments set up on racial and regional bases. With ongoing negotiations around a new political dispensation, there is the welcome promise of a unified system being introduced in the near future. However, the dynamics described in this article are likely to continue for a considerable while. I also acknowledge that the complexities of South African society and its education systems are far too large to attempt to summarise briefly; the following brief comments on mathematical education in South Africa cannot do justice to the situation, where many different challenges to the *status quo* come from political as well as professional and community sources.

The remaining paragraphs of this opening section are interspersed with some observations about Logic made by a Jungian analyst, Julian David, in a lecture given (in July 1992) at the University of Cape Town. The quotations can be read consecutively: they summarise the main theme of my article which focuses on a single initiative in which I am involved.

In South Africa, the teaching methodology for mathematics is generally restricted to the transmission of facts and algorithms by the teacher, and the pursuit of right answers. Learners work separately and competitively in the name of excellence. Success is determined by end-of-year examinations which control access to higher levels. In some cases, this assessment starts in the child's first year at school. Failure generally means repeating the standard, although the pressure of an increasing school-going Black population means that pass levels are suitably adjusted to ensure that there can be sufficient accommodation of learners at the lower levels. This makes it not unusual to have senior mathematics classes where the majority of learners last passed mathematics three or four years earlier. Control of learning is generally exercised through regular weekly tests and half-yearly examinations which ensure that all classes work in the same way and at the same speed.

Western worship of intellect goes back to Socrates and Plato. The leading element was Logic – causality in the abstract – and this gave birth to the industrial revolution. Psychologically it conferred power.

The existence of nineteen different Education Departments in the country, based on regional, racial or "independent homeland" criteria, means that there is a wide spread of realities in schooling. Resourcing in schools ranges from fully equipped schools with libraries and computer laboratories to schools with no electricity and minimal support technology. Estimates for expenditure per learner for 1989-90 were R930 per Black child, R1983 per

"Coloured" child, R2659 per Indian child, and R3739 per White child [1]

The founding principle of Logic is that opposites exclude each other. So Logic whips through the world dividing things. All dualities are splits that initially increase consciousness, for there is indeed a distinction to be made.

Mathematics is strongly used as a filter for work, and for access to further education. The enormity of this filter can be seen from the mathematics examination. In white schooling in the Western Cape in 1990, 3533 sat the Higher Grade Mathematics examination with a 86% pass rate! In comparison, 1152 Black students in the Western Cape sat the examination with a 16% pass rate. The figures for the whole country show that 8% of the 253623 Black matriculation candidates achieved passes that might allow them access to further study at university, compared to 41% of White candidates [2]

Logic also homogenises – for if things are not different they must be the same. Logic classifies, and within classes, everything must be the same. Logic encourages separateness, class war and apartheid. Logic lacks humanity.

The dominant discourse in understanding learning is informed by cognitive and behavioural psychology; it centres around learning hierarchies, learners' set stages of development, and effective and appropriate teaching strategies for these developmental stages. The search is for diagnostic tests which will identify a pupil's misconceptions. Time is linear and segmented into 35-minute periods. Children have been shown to have limited attention spans: so lessons have to be structured to ensure that this maximum attention span of 20 minutes is optimally used. Control is essential to optimise learning and the constraints of the classroom structure mean that no time can be wasted on individual attention.

Logic is crucial in developing effective ego-consciousness. Plato could not bear the changeableness of the sub-lunar world. He was anxious about flux and wanted something to hold onto. Logic gave him stability. Its abstractions offered a more satisfactory world altogether – a world of eternal truths, where there would be no change. Mathematics gives access to immortality – eternal, unchangeable truth.

And the system keeps people separate. Even when they share facilities they make no real contact. Collective assumptions of fear and prejudice remain firmly in place and apartheid succeeds in its task of division. Problems in the country are solved by Logic which may have unfortunate consequences such as men having to live apart from their families, or communities having to be moved. But it all takes place according to the problem's rational solution.

The other functions of the psyche – feeling, sensation and intuition – were the dross. Without feeling, thinking is necessarily destructive. Thinking without feeling is not the God Plato thought it would be, it is closer to the Antichrist.

Creating an opposite

My task is to train mathematics teachers to go out into these different departments to teach. The students who come to me for a year's teaching diploma have completed a three year degree and will have taken mathematics as a subject in that degree. Although the hope is that this mathematics will at least be at a second year university level, the reality has been that many teachers with one year's mathematics will probably end up teaching the subject.[3]

The students coming to the course are generally the successful products who have survived the schooling system and have found security in the certainty of mathematics. In a country which is wracked with conflict they believe that they have found a subject where they can take respite from the outer turmoil and can bring their powers of rational thought to bear on problems. White males generally form the initial dominant group, but nearly all students are extremely success-oriented. Mathematics is a subject where one can show one's superiority. Most of the class come in the expectation that I will give them some skills, tips and a few extravagant frills, so that they will be successful teachers whose learners achieve excellent examination results. The students form a mixed group from the different sections of the country. Many of them have spent the past three years at the University, but it is unlikely that they have communicated with each other to any real extent during this time. They have learnt the secret of success: be good, conform, work hard, and you will assuredly be rewarded.

I was under the impression that maths is supposed to be a precise language without ambiguity, and once a set of instructions has been given they can only be interpreted in one way [4]

My description of the situation and the students shows some of my biases. My task has been to develop a course which challenges the assumptions of this version of the *status quo*. Initially I based my challenge on intellect, and on my authority and experience. This approach had little effect. Students would listen politely to the lecture, even argue a little, and then carry on with their beliefs and actions. Having lost the contest of challenging reason with reason, I decided to tackle the situation from a different perspective. I turned my attention to the dross mentioned in the first section – feeling, sensation and intuition.

The major thrust of my course becomes an assault on the affective side of learning, and specifically on feeling. From the start, students concentrate on meeting each other and on learning each other's names. They also play games involving physical contact.

In the first lecture we were most certainly conscious of ourselves and of others and the touching of hands, especially with the white students, made me feel very uneasy with myself.

Students are required to keep a diary and to reflect after each week's session on anything that they learnt about themselves as teacher, learner and mathematician. Wherever possible, I provoke conflict through the use of activities and incidents which aim to highlight hidden assumptions and socialisation within the existing system. For example, I role-play an authoritarian teacher who gives them a test and puts them in touch with the degree of fear and abuse they have accepted as normal at school.

In addition to setting up activities in opposition to the *status quo*, I attempt to provide an alternative image of what learning could be like, by placing an emphasis on group interaction which welcomes and encourages the affective side of learning and respects the exploration of ignorance. I use a piece of writing about rabbits and moles to further describe the possibilities of a different form of learning mathematics.

I introduce a different language to describe classroom interactions which includes concepts such as risk, energy, trust, and play. I stress the power of the active imagination of the young child – an important figure in the romantic literature of Wordsworth, Blake and Rousseau – and the responsibility that we have to protect the little child from being killed at school.

In addressing issues about mathematics content and methodology, I emphasis imagination and intuition. According to Michael Meade, "there are five great appetites – eating, drinking, breathing, thinking, and imagining. While people can do without the first four for varying lengths of time, the moment they stop imagining they die." [5] I try to recapture the power of intuition by focusing on the section of euclidean geometry in the schools syllabus and show how this can be taught in an informal manner using Gattegno's description of geometry as an awareness of imagery. We use moving acetate sheets, Nicolet films, ourselves as apparatus, and so on. I extend this into algebra and use the familiar investigations where visual solutions play a powerful alternative.

Some of the students react to this approach with resistance and suspicion:

Maybe it is true that I actually like maths because of its safety. But I do not think there is anything wrong with that. I also believe that you as teacher should realise that pupils see you as a role model and to ensure that you are very objective in the classroom you should not bring your own emotions and beliefs into it. The maths classroom is not the place to express your emotions – it is a place where rational thought should be encouraged. Not all people value emotions as important. For some, like myself, life can be dealt with quite rationally.

However, the extent of their impoverishment of the affective and intuitive side of mathematics means that there are enough obvious benefits to keep most of the class enthusiastically involved. As the year goes on and they find that they can bring the many dimensions of their experience of the world into the lecture room, they become excited at the possibilities, and sometimes extremely critical of the lack of preparation school and mathematics has given them for life.

Teaching maths: this is the picture of life... maths is... structured, single solutions, safe, without politics, without ethics or morals, logical, ordered, tight... no human element in it. No, neither school nor maths helps in crises.

School holds illusion that there is a single way to go. You will be rewarded if you do your homework and get good results. Dismay when it doesn't work out that way. Life is not fair. Doesn't reward the good. What have I done to deserve this? Don't show emotions! Don't show you can't cope. Shame to ask for an extension for work. What will people think of me? Must show I'm OK.

One activity that students undertake in my course is a period of observation of the moon. Comments in their projects suggest that there is value in seeking commonality in the apparently disparate topics of moon-watching and mathematics:

While I am looking at the moon I try to relate some mathematics to it. I find this difficult to do because the moon looks so peaceful and abstract while mathematics appears very rigid and complicated.

I feel about as fuzzy and vague as the moon looks. Maybe how the moon looks to me now is how maths looks to a Std 6 pupil. The problem is that the clouds are very subtle, there's no knowing where they are or what they are made of. If only I could move those clouds.

By the time the course comes to an end the students are generous in their praise for their learning experience, generally rating it as the most important course of the year. In particular they record their appreciation for the physical contact and opportunities for social interaction.

Our interaction with each other as people is really what a lot of it is about. And a large part of this is seeing things from others' perspectives.

Some are filled with strength and optimism to harness these new insights into a different approach to life.

Break down the walls of fear. We need to face our conflicts. Really, what's the worst that can happen? Sometimes we need to break the order that suppresses us. Don't fear the chaos. When we understand the aesthetics of disorder – the Poetic of the Pragmatic – we'll think in curves around the mundane, the conventional.

Conflict with opposites

Initially I had hoped that these student teachers would go out into the schools, taking the insights that they had gained during the year, and find areas where they felt comfortable to start introducing change. Reality shows that the problem begins when these same students start their careers as teachers. Most of them find themselves isolated within the school when they start talking about issues which are not considered legitimate. They meet the full force of inertia that preserves the dominant structure, and they are left to choose one of three major routes. Some have learnt to feel too keenly and cannot stay in a system which undermines learners. They leave teaching, often

with a sense of having failed both themselves and me in some way. Others know that their own survival is crucial and they adapt their teaching to that required by the school, planning to get around to introducing something different "one day" when conditions change. They feel that the problem is greater than anything that they can handle.

I think that the system destroys or discourages any form of creativity. Firstly, classes are overcrowded or the rooms are too small to accommodate any form of group work or individual attention. Secondly, society is not concerned in creating thinking or critical people, but merely people who can pass exams. Students are regarded as products on a production line. The teacher is the foreman and has to ensure that the products are properly packaged. Students have become accustomed to the authoritarian way of teaching. They often abuse teachers who try to introduce an environment of more freedom. Before creativity can be introduced successfully in the classroom, society will have to change and become less authoritarian.

Finally, a few become totally disillusioned with what they received in my course, and become a willing part of the school system.

Wise up, folks: very few true professionals are fascists. Your course needs to be relevant to teaching, not some airy-fairy progressive ideology that congealed in 1965 and is now growing a good penicillin culture.

The temptation at this stage is for me to react strongly and to make more of an effort to engage with the enemy by attempting to package a new product which covers all possibilities and relies on missionary teachers to carry out the revolution.

In fact, someone has already started. A South African initiative, which is based on a socio-constructivist approach to mathematics teaching, focuses on discovery methods at the primary school level. It is known as the "new maths", although it is really the old maths taught by a new methodology. The initiators have used the established hierarchical route. The battle is on as university mathematics departments and threatened teachers, parents and learners, register their disapproval.

I am not sure that I want to engage in such a battle. In order to compete I have to adopt the language of the opposite and belittle the powers of Logic. Yet it is, not Logic per se that I am against, it is the use of Logic without feeling. This distinction will get lost in the battle. The very act of engagement means that I have to give up the empathic basis of allowing the affective into mathematics. So my problem remains. How do I react to the realities that face my students as they enter the teaching profession? What expectations can I put on them without placing them in no-win situations?

Living between opposites

Opposites are part of each other and cannot be separated. Logic cannot take in its own need for an opposite. The psyche resides in the uniting of the opposites which brings life to the whole and makes it qualitatively more than the sum of its parts.

To live between the opposites means that we not only recognise opposites, but rejoice that they exist. To live between we stretch out our arms and push the opposites as far apart as we can, and then live in the resonating space between them. Living in the opposites does not mean identifying with one side and then belittling the other..... Rejoicing in the opposites means pushing the opposites apart with our imaginations so as to create space, and then enjoying the fantastic music coming from each side [6]

So this gives me a reason to disengage from the context. I can reassure myself that what I have been doing in offering the experience of a different learning environment has been to push the opposite of traditional, authoritarian, transmission-based teaching methodology as far as I can in the other direction. Having done that, my section of the task is finished. It is up to my students as individuals with new awarenesses to listen to the music coming from each side and to choose an appropriate range of options that celebrate their own teaching context.

Joseph Campbell's response to the disenchantment of modern life was: find your life's passion and follow it, follow the path that is no path: "Follow your Bliss". When you have the unmistakable experience of the Aha! then you'll know you're riding on the mystery. This mystery he associates with inner work and goes on to identify the world of the arts and literature as being the world in which to find all this. [7] This approach places Mathematics and the Liberal Arts as opposite poles - the one feeding thinking and the other feeling. The task in life then becomes one of ensuring that the two polarities are balanced. Presumably a successful approach to a developed life will see mathematicians ensuring that there is a healthy balance of art and music in their diets.

Robert Bly sees the opposites in terms of light and dark:

We notice that when sunlight hits the body, the body turns bright, but it throws a shadow, which is dark. The brighter the light, the darker the shadow. Each of us has some part of our personality that is hidden from us. Parents, and teachers in general, urge us to develop the light side of the personality - move into well-lit subjects such as mathematics and geometry - and to become successful. The dark part then becomes starved..... If any help was going to arrive to lift me out of my misery, it would come from the dark side of my personality [8]

So we leave mathematics in the light. Bly's experience matches those of the students quoted earlier in finding the lessons of mathematics inappropriate for the tragedies of life.

But I feel uneasy with this. One of my primary students spent a year doing a mathematics content course last year. She had last passed the subject at the age of 13 and considered herself a failure at mathematics. We spent the year trying to recapture her powers to visualise and trust in her own logical and intuitive strengths. At the time of the examination, even though she was working in a pair with a friend, she found the occasion too much and burst into tears. She narrowly failed the examination.

After acknowledging her renewed sense of failure, she recognised how far she had come in a short time to be almost able to pass an examination that people with a stronger mathematical background had struggled over. She decided to make a last effort to pass the supplementary examination paper. She prepared by working with a friend and went through the ups and downs and crises of self confidence. As the only failure she had the added handicap of having to write the examination on her own this time.... This time she passed the examination with something to spare.

Towards the end of this year her father died tragically and she was filled with grief. As we said our farewells at the class's last lecture, she told the class how the experience of looking at her fear of mathematics, of re-engaging with the subject in a different way in which she had some power and control, and of coming to terms with mathematics sufficiently to allow her to pass an examination had contributed enormously to her ability to find the strength to cope with her father's death.

This is not a story about the light of mathematics - there's a lot of dark shadow present!

What if the opposites are two aspects which are very real parts of mathematics. The dual nature of mathematics has been acknowledged by Hilbert:

In mathematics, as in any scientific research, we find two tendencies present. On the one hand, the tendency towards abstraction seeks to crystallise the logical relations inherent in the maze of material that is being studied, and to correlate the material in a systematic and orderly manner. On the other hand, the tendency towards intuitive understanding fosters a more immediate grasp of the objects one studies, a live rapport with them, so to speak, which stresses the concrete meaning of their relations [9]

It seems to me that the teaching of mathematics at schools has an incredibly important role to play. If these opposites are already obviously present in mathematics, rather than be fooled into the support of the one at the expense of the other, we should be trying to allow both into our conscious practice. An important parallel exists in physics where the tension caused by the dual existence of light as wave and particle has led to greater understandings of physics as well as bringing it closer to existential questions.

For example, Kopp describes an Eastern perspective which views life as spiral from infinity in counterclockwise direction. The task in life is to return to infinity. He goes on:

In the law of the Tao, the underlying concept is the idea of change. The apparent opposites, the yin and yang of male and female light and dark, firm and yielding, all are forces arising out of change. There is never one pole without the other, no truth without a valid opposite, no going far enough in one direction without coming full circle [10]

The concepts of the circle, infinity and positive and negative asymptotes lie within the field of mathematics. What do we really know about them, and how much more could

we find out if we allowed both aspects of mathematical thought to be engaged?

Listening to the music

My task seems to be to go a step further than to just push out the opposites and leave it for my students to make what they want of it. There is another step which is far more crucial, especially in a country which has depended on the hostility between the opposites to rule and divide. We need to break the stranglehold that unfeeling Logic has placed on society through its divisive actions and to provide an example which celebrates the holding of the tension of the opposites. I believe that mathematics provides the appropriate arena to begin this task as the very nature of mathematics allows us to celebrate both feeling and thinking, intuition and logic. This is my next challenge.

I'm not sure where this path is going to lead, but there are a few pointers giving direction. David Henderson has identified Geometry as his bliss, and this seems to provide an ideal entry point for holding these two opposites together. School geometry in South Africa is limited to euclidean geometry and, although in the initial years learners are encouraged to use intuitive proofs, the main purpose of the topic is to demonstrate a logico-deductive system at work. Teachers know this reality and either ignore or downgrade the intuitive aspects of the subject. Few learners leave school or university knowing that there are other forms of geometry.

The Steiner schools include topics such as conic sections and projective geometry in their work and accentuate the interconnectedness of different shapes and graphs from different perspectives and transformations. The concept of infinity seems to offer enormous richness in developing an image of where the opposites might meet. Perhaps a thorough study of projective geometry would be an appropriate place to begin to listen to the music from both opposites.

These thoughts signal a specific and valuable role for mathematics, but the principle can be applied to the other opposites: top-down/bottom-up, male/female, right/wrong, teacher-/learner-centered. It may have been strategically correct to challenge one reality with the opposite to draw attention to the situation and increase the possibilities for action, but little will be achieved if there is no serious attempt to find a position which allows the opposites to coexist together.

So if the challenge now became to create and explore mathematical topics at school where Logic was valued and so was Intuition and Feeling, we might be giving examples of holding opposites that would serve as life preparation rather than as destruction. It will be important to assign equal status to both intuitive and abstract processes. But the equality of status should also be judged less strictly and more in keeping with the tenor of Michael Meade's thoughts:

I've had trouble sometimes with the word equality. People - especially those trained in this culture say equal and you get the image of a mathematical equation. Those kind of equals often look static. I have trouble with the idea that they are static. I much prefer dance. Both empowered - both in beauty - both in

spontaneity - rather than statically equal I prefer the idea of dancing partnerships. That wind up in some great summation as being equal, but while we're watching it looks much more like the expression in flamenco, where the woman looks beautiful, passionate, fierce, lonely. And then the man looks staunch, beautiful, fierce, lonely. And there they go - kind of asymmetrically, ambiguously, spontaneously dancing on - rather than statically equal.[11]

Jungian ideas are closely linked with myths, and it is hard to identify mythical figures which relate readily to the traditional world of mathematics. Certainly the Trickster and the Lover seem to have no place to roam. Devotion to Logic also seems to squash any space for Dionysian energy to dance. So another important starting point will be to identify the archetypes which can relate to and enrich the world of mathematics.

Notes

- [1] South African Institute of Race Relations, *Race Relations Survey*, Johannesburg, 1991-2, p195
- [2] Data from relevant Departments (October 1991), and from the *Survey* cited in previous note, p210
- [3] For a fuller description of the evolution of this course, see C Breen, "Teacher education and mathematics", *Perspectives in Education*, 13 1 (1992) 33-44
- [4] This and the other italicised paragraphs in this section are taken from the journals written by student teachers as part of their course
- [5] M Meade, in R. Bly et al, *Men and the life of desire*, audiotope, Oral Tradition Archives, California, 1991
- [6] R. Bly, *Iron John*, New York: Addison-Wesley, 1990, p175
- [7] P Cousineau (ed), *The hero's journey: Joseph Campbell on his life and work*, San Francisco: Harper, pp xvi, 134
- [8] R. Bly, *A little book on the human shadow*, Shaftesbury: Element Books, 1988, p7
- [9] D. Hilbert & H. Cohn-Vossen, *Geometry and the imagination*, New York: Chelsea, 1952, piii
- [10] S. Kopp, *If you met the Buddha on the road, kill him*, London: Sheldon Press, p25
- [11] M. Meade, in R. Bly et al, *op cit* (note 5)

