Transformative Professional Development of Science Educators: Sustaining Cultural Diversity in a Globalising World

تحولی در آموزشگران علوم: حفظ تنوع فرهنگی در دنیای جهانی شده

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How can educational research enable future educational leaders to transform the educational policies and practices of their institutions in culturally inclusive ways? In addressing this question I draw on 20 years of experience mentoring postgraduate researchers in science and mathematics education from countries in Africa, Asia and the Pacific islands. A major challenge is to provide appropriate methods for intercultural research which address the key question of how to design culturally inclusive science education systems for preparing young people in 'non-Western' societies to enter the modern (globalising) world and, at the same time, respect, celebrate and grow their own local cultural capital. Exciting developments in contemporary qualitative research enable postgraduate researchers to use their own life-world experiences as a primary source of data for examining critically and creatively key philosophical and political assumptions underpinning teaching, curriculum and research practices in their own countries.

Key Words: Science Educators, Cultural Diversity, Globalising

پژوهش در حوزه‌ی آموزش چگونه می‌تواند بـه متخصصـین آموزش در آینده کمک کند تا سیاست‌هـا و اقـدامات آموزشـی مؤسسات را به گونه‌ای که در برگیرنده‌ی فرهنگ باشـد تغییـر دهند؟ در پاسخ به این پرسش نویسنده‌ی مقاله‌ی حاضر بـه ۲۰ سال سابقه‌ی خویش در زمینـه‌ی آمـوزش پژوهشـگران مقطع کارشناسی ارشد در حـوزه‌ی آمـوزش علـوم و ریاضـی در کشورهای آفریقایی، آسیایی، و جزایر اقیانوسـیه رجـوع کـرده است. یکی از چالش‌های عمده، ارائـه‌ی روش‌هـای صـحیحی برای انجام پژوهش‌های بین‌فرهنگی می‌باشد که به ایـن سـؤال اساسی می‌پردازند "چگونه باید نظام آموزشی علـوم طراحـی کرد که در بر گیرنده‌ی فرهنگ بـوده و همچنـین نسـل جـوان جوامع غیرغربی را برای ورود به دنیای مدرن (جهـانی شـدن) آماده سازد به گونه‌ای که آنان همزمان به سـرمایه‌ی فرهنگـی- محلی خویش نیز احترام گذاشته، آن را ارج نهند و به رشـد آن کمک کنند؟" پیشـرفت‌هـای قابـل توجـه معاصـر در حـوزه‌ی پژوهش‌های کیفی به پژوهشگران مقطع کارشناسی ارشد کمک می‌کند تا از تجارب زندگی خود به عنوان منبع اولیه‌ای از داده-ها جهت بررسی ناقدانه و خلاقانه‌ی فرضیه‌های کلیدی فلسفی و سیاسی کـه اسـاس تـدریس، برنامـه‌ی درسـی، و اقـدامات پژوهشی در کشور آنها را تشکیل می‌دهند بهره جویند.

کلید واژه‌ها: مربیان علوم، تنوع فرهنگی، جهانی سازی

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Education for All - Cultural Diversity

My role as a teacher educator and research mentor in a university graduate centre specialising in science and mathematics education is to engage experienced teachers (and teacher educators) in postgraduate professional development.

In this paper I mention three of my recent graduates – Dr Alberto Cupane and Dr Emilia Afonso of University Pedagogica in Mozambique and Dr Bal Chandra Luitel of Kathmandu University in Nepal. The majority of our professional students are from other countries and many are sponsored by the Australian Government's foreign aid program, especially those from (in their own words) "developing countries"[i]. There

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One of the major outcomes of my doctoral research was an enhanced consciousness of my Mozambican identity. It is something that can be hardly characterized. My identity includes:

> *my body and the bodies of others*
> *my colour and the colour of others*
> *my language and the language of others*
> *my country and the country of others*
> *my relatives and those who I know*
> *my relatives and those who I don't know*
> *my soul and the souls of others*
> *my spirituality and the spiritualities of others*
> *the others are me and*
> *I am the others*

(Cupane & Taylor, 2010)

is great variation in cultural backgrounds. Some have grown up in traditional village lifestyles, some in urban environments. Some are from non-Western (Hindu, Buddhist, Islamic) cultures, some from nations with multi-tribal populations. Many are from countries that have recently gained political independence from former European colonial regimes (e.g., Mozambique, Namibia, Philippines). One commonality amongst these elite professionals is that during their school education they were highly successful in learning conventional

science and mathematics, a success attributable to negotiating a cultural border crossing (Giroux, 1993) from their local (Indigenous) culture into a Western modernist worldview[ii]. During postgraduate studies it soon becomes clear, however, that only a few of these professional educators have reflected critically on their roles as agents of enculturation of their own students into this worldview. Most have not thought to challenge the cultural assumptions underpinning their conventional curricula. At the outset of planning their research dissertations/theses most initial research questions are usually of a politically neutral (naïve) 'how to' nature:

• How can student participation and achievement in education be improved by innovative teaching approaches?

Such a well-intentioned but narrowly conceived question, however, does not afford critical examination of the cultural relevance of existing curricular structures to the unfolding development of their societies (questions of 'why?' and 'who?'). In other words, many of these elite professional educators seek to reform (improve marginally) rather than transform (radically renew) their professional practices. Why is this so? The answer lies in the invisible part of the political spectrum which frames hidden assumptions about how to generate legitimate academic knowledge, assumptions with roots in conventional science and mathematics education.

Although I hold that science and mathematics education are valuable because they have the potential to contribute to vastly improving the quality of our material lives, unless they are handled with great care they can be harmful to cultural and environmental health, especially in pre-industrial societies undergoing rapid modernisation. The globalisation of science curricula is a process of exporting to many parts of the planet a powerful (albeit naïve) Western modernist worldview rooted in (largely unexamined) European Enlightenment assumptions and values and 'policed' by tightly controlled international benchmarking systems of comparative assessment (e.g., TIMMS: http://nces.ed.gov/timss/).

How different is this process to the earlier European colonisation movement which imposed a 'civilising' education system on colonised peoples that suppressed their local knowledge and language systems and severely undermined their cultural integrity, identities and livelihoods (Aikenhead & Michell, in press)? Postcolonial

> I'm interested in **the politics of cultural identity formation** (Banks, 2001; Golmohamad, 2004) and the role of science education in manufacturing young people's cultural identities, an issue of paramount significance in a postcolonial world in which the West's historical tendency to define social reality for others is being contested politically whilst being acceded to, in part, through the powerful vector of the international science curriculum export industry.
>
> Taylor (2006)

scholars argue that today's globalisation is the latest manifestation of colonialism (i.e., neo-colonialism), albeit at a more subtle level (e.g., Semali & Kincheloe, 1999).

Although the Western modernist worldview offers a host of material benefits (e.g., modern medicine, transport, communication, agriculture, engineering), sustainability educators argue that its side effects are destabilising the future of humankind, contributing significantly to global warming, air/water pollution, species extinction, natural resource exhaustion - to name a few (Australian Government, 2009; Fien, 2001; Skutnabb-Kangas, Maffi & Harmon, 2003).

Of particular concern to researchers in the emerging field of the cultural studies of science education is that at the heart of the Western modernist worldview lies a narrowly conceived view of the nature of science - *positivism* - which not only grossly oversimplifies the ways in which many Western scientists conduct their work (thereby blinding us to their creative inspiration, intuition, imagination) but also fails to account for 'post-Newtonian' or 'post-modern' science that embraces quantum theory, complexity theory, and chaos theory.

The paradigm of positivism, which arose from the Newtonian 'linear mechanical' worldview, is an epistemology for attaining justified true belief (or certain knowledge) about the nature of physical reality.

Positivism comprises an ontology of *naïve realism* purporting an external reality that is fully apprehendable by means of:

- a dualist (mind/body, subject/object) rationality employing analytical, propositional, deductive logic which abhors contradiction
- quantitative experimental research design seeking generalisable natural laws;
- a disinterested (value neutral) researcher posture
- a fixation with materialism and indifference to metaphysics (especially consciousness and spirituality)
- research standards of objectivity, reliability and validity

Positivism produces propositional knowledge that is believed by its proponents to be context free, that is, transcendental of culture. The social sciences have adopted a 'softer' post-positivism based on a *critical realist* ontology which recognises the impossibility of fully apprehending reality, settling for closer and closer approximations. The positivist paradigm gives rise to an ideology of 'scientism' which holds that Western science is a privileged knowledge system superior to alternative ways of knowing the physical (and, many argue, the social) world (Smith, 1996). In 20th Century Western universities the paradigm of positivism was the 'gold standard' for regulating postgraduate research. But there is good news. The recent emergence of rival paradigms – interpretivism, criticalism, postmodernism - has begun to counter this hegemony (Taylor, Settelmaier, & Luitel, in press).

Cultural studies researchers have demonstrated how, in the grip of the positivist paradigm, science and mathematics education serves to devalue and delegitimate local knowledge systems and cultural identities by turning a blind eye to alternative (perhaps more sustainable) ways of living with nature, known as *traditional ecological knowledge* or *Indigenous ways of living in nature* (Aikenhead & Jegede, 1999; Kincheloe & Tobin, 2009; McKinley, 2005; Waldrip & Taylor, 1999).

Thinking globally, we appear to be at a bifurcation point in the evolution of our planet: either our societies continue on the tragic path of diminishing their cultural, linguistic and biological diversity and voraciously consuming non-renewable energy resources or we (collectively) break through into a higher level of sustainable global development marked by peaceful co-existence, careful conservation of the Earth's natural and cultural treasures, and mutually rewarding collaboration. If we are to follow the latter pathway then perhaps we need to develop a higher level (or integral) consciousness that seeks synergy between multiple (currently antagonistic) worldviews (Laszlo, 2008). But how likely is this to occur given the widespread practice of rapidly modernising countries importing uncritically Western science curricula which, like Trojan horses, carry the seeds of a culturally invasive and homogenising positivism? But there is hope!

Recently, the iron grip of scientism has began to weaken in response to growing demands for socially relevant curricula and humanistic pedagogies responsive to the processes of learning, to the diversity of cultures, and to global crises such as climate change. In Australia we are beginning to witness science classroom environments being fashioned by the following humanistic perspectives.

– *constructivist learning theory*, which emphasises the pedagogical importance of focussing on the learner's cognitive, emotional and social meaning-making processes, leading to student-centred activities of inquiry oriented problem-solving, collaborative learning, and authentic learning tasks

– *critical social theory*, which promotes a democratic ethos and raises critical awareness of social justice issues, resulting in gender-inclusive science curricula and text books and the 'Indigenisation' of the curriculum in the form of Australia's new Primary Connections science curriculum - *www.science.org.au/primaryconnections/indigenous/*

– *education as/for sustainable development*, which is promoting the role of values learning, leading to students' development of a critical consciousness

about ethical dilemmas arising from misuse of science and technology and of critical literacy skills needed to engage in future decision-making to ensure the socially responsible use of science and technology (e.g., Hodson, 2008; Settelmaier, Taylor & Hill, 2010).

So, how do we prepare teachers capable of developing professional policies and practices that embody these radically new perspectives? This is the challenge for teacher educators and research mentors (such as me) who wish to enable educators to develop the 'eye of wisdom' (Hart, 2009), to find ways of providing transformative professional development aimed at <u>expanding</u> (pluralistically) their conventional positivist worldview. The first step is engage them as transformative learners; researchers as learners (rather than provers).

Transformative Professional Development

One of the growing influences shaping teacher education is transformative learning theory which emphasises, amongst other things, the importance of developing critically reflective teachers (Cranton, 1994; Brookfield, 1995). As a teacher educator I strive to empower my postgraduate students with a transformative perspective with which to question critically and personally their own standing in the world as professional educators. They learn to direct their learning (and their research) by asking the following transformative questions:

- What are the key social, cultural and political challenges facing my rapidly changing society?

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When I subsequently returned to Mozambique and to my practice as a science teacher educator at Universidade Pedagogica, though conscious that learning never ends, I felt empowered to discuss more deeply with my students issues of science in our cultural context. I have been encouraging them to learn from themselves. To interrogate their own attitudes toward learning and teaching science as well as their colleagues' and teachers' attitudes. To discover hidden subjectivities they have as Africans, especially in the context of the school science classroom.

(Nhalivelo, 2010)

- Whose cultural interests are not being well served by traditional educational policy and practice?
- Who are these students whom I greet every day? What are their worldviews, languages and life-long learning needs?
- Who is the cultural self who teaches? What key life-world experiences and values underpin my own professional practice and aspirations?
- What is my vision of a better world and how can my own professional practice help to realise it?

Transformative learning is an holistic experience involving students in much more than passively consuming bodies of disciplinary knowledge. My vision is for transformative professional development to afford rich opportunities for professional educators undertaking postgraduate study to undergo a metamorphosis towards the 'getting of wisdom' by investing in the growth of their own cultural capital and becoming producers of culturally situated curricula (Henderson & Kesson, 2004). Such a transformation in personal agency involves developing diverse ways of thinking and new modes of consciousness - *critical reflective thinking, metaphoric reasoning, dialectical thinking, metacognition, spiritual awareness, poetic thinking, integral thinking, envisioning* (O'Sullivan, Morrell, & O'Connor, 2002; Palmer, 1993).

However, despite progress towards transformative learning in teacher education, one of the last remaining obstacles to be overcome is postgraduate research, especially for science and mathematics educators many of whom remain imbued with a Western modernist worldview. In my experience, the main barrier to engaging mathematics and science educators as novice transformative researchers is their deeply embedded assumption that positivism is the privileged epistemology of research for the social sciences which, in its extreme form, honours the following principles:

- valid and reliable knowledge can be produced only by means of objective, value-neutral inquiry,

- research is a theory-testing deductive process of manipulating variables that have been pre-defined by expert others,

- bridging the 'theory-practice gap' in education involves privileging the theoretical voices of expert academic researchers,

- research report writing involves writing 'voicelessly' (3rd person, past tense, passive voice) in a preordained, one-size-fits-all template with a linear structure - Introduction, Literature Review, Methodology, Results, Conclusions, Recommendations.

> **Transformative learning** involves experiencing a deep, structural shift in the basic premises of thought, feelings, and actions. It is a shift of consciousness that dramatically and permanently alters our way of being in the word. Such a shift involves our understanding of ourselves and our self-locations, our relationships with other humans and with the natural world; our understanding of relations of power in interlocking structures of class, race, and gender; our body-awareness; our visions of alternative approaches to living; our sense of possibilities for social justice and peace and personal joy.
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> (O'Sullivan, Morrell, & O'Connor; 2002, p. xvii)

Clearly there is not much space in this model for the novice educational researcher to show evidence of their transformative growth! Nevertheless, my intention is not to deconstruct positivist research (in fact I continue to practice a small amount of it - see Yeo, Taylor & Kulski, 2006) but to loosen its hegemonic grip on professional educators' worldviews. My transformative goal is to open the minds and hearts of science and mathematics educators to alternative epistemologies of inquiry. And to this end I offer critical auto|ethnography which integrates multiple paradigms of educational research: interpretivism, criticalism and postmodernism (see Taylor, Settelmaier, & Luitel, in press for a detailed argument).

Critical Auto|ethnography

The field of contemporary qualitative research offers many promising methods for engaging in transformative professional development (e.g., Denzin & Lincoln, 2005; Green, Camilli, Elmore, & Grace, 2006). Of special interest to my research mentoring is critical auto|ethnography which is situated at the nexus of *ethnography, writing as inquiry, arts-based research, narrative inquiry, evocative autoethnography, anthropological poetics, philosophical inquiry, critical hermeneutics* and *practitioner inquiry*. For science and mathematics educators undertaking

> **Evocative autoethnography**. My open text consciously permitted readers to move back and forth between being in my story ad being in theirs, where they could fill in or compare their experiences and provide their own sensitivities about what was going on…to feel that in describing my experience I had penetrated their heads and hearts...I hoped they would grapple with the ways they were different from and similar to me
>
> (Ellis, 1997, p. 131)

postgraduate professional development, especially in the context of cultural studies, this transformative approach enables design of a methodology to inquire critically, reflexively and artfully into the relationship between the researcher's own cultural identit[y/ies] and his/her lived experience as a consumer (i.e., student) and (re)producer (i.e., teacher, teacher educator) of education.

Critical auto|ethnography involves writing not simply as a process of reporting on a completed inquiry but, more importantly, as a process that is constitutive of the act and art of inquiry: the researcher inquires as s/he writes (Richardson, 2000). The autobiographical aspect fosters excavation of deeply sedimented cultural memories thereby enabling the researcher to identify and examine their personal experience of historically established

> **Auto|ethnography.** I use the slash '|'…because …the individual and its society - which is the seat of the social and the cultural - mutually presuppose one another. They stand in a dialectical relationship.
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> (Roth, 2005, p. 3)

educational policies and practices (Taylor & Settelmaier, 2003; Pereira, Settelmaier & Taylor, 2005). Through authoring and reflecting in critical and scholarly ways on their personal-cultural narratives researchers can recover and reinvest in their cultural capital, an important step in the process of personal and professional transformation. To develop one's authority as a producer (rather than reproducer) of cultural knowledge is a step towards decolonizing both one's research and one's professional practice (Mutua & Swadener, 2004).

When applied reflexively to the academic culture of research, critical auto|ethnography involves decolonising the researcher's practice of inquiry by identifying, contesting and reconceptualising residual positivistic research requirements, especially conventional validity criteria and thesis/dissertation structures. Critical reflexivity enables the researcher to keep alive the spirit of critical interpretive (or hermeneutic) inquiry characterised by the *emergence* of unanticipated research questions, new methods of inquiry and thematically structured report writing (Stapleton & Taylor, 2003).

In making sense of the research status of the personal-cultural knowledge outcomes of critical auto|ethnographic research it is important to understand the *post-epistemological* perspective of this approach (Taylor & Wallace, 2007). In the postmodern research era conventional research standards have been reconceptualised in a variety of ways, amongst which are standards of emergence, verisimilitude, dialogical voice and critical reflexivity (Barone & Eisner, 2006; Clough, 2002; Ellis & Bochner, 2000; Knowles & Cole, 2008; Van Maanen, 1988). Quality standards for critical auto|ethnographic inquiry can be drawn creatively from the following fields of research:

- **Anthropology:** an *ethnographic* approach to generating rich understanding of a cultural group's worldview perspectives and practices and adaptive responses to the challenges of modernisation.

- **Self-study**: An *autobiographical* focus on exploring one's own lived experience as a member of a cultural group adapting to challenges of moving across cultural borders into other discourse communities.

- **Criticalism**: An *emancipatory* interest identifies and deconstructs the distorting influence of powerful systems of thought and action (such as the Western modernist worldview) that have colonised historically a cultural group and continue to maintain a powerful and discriminatory presence by virtue of their hegemonic invisibility and uncontested political values.

- **The Arts**: A *postmodern* perspective on artful inquiry uses literary genres and logics to evoke multiple modes of thinking and feeling with which to communicate complexity, ambiguity and paradox

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My recently completed doctoral dissertation has addressed the protracted problem of the culturally decontextualised nature of mathematics education which un/wittingly prevents many school students from gaining full access to powerful mathematical ideas. With an emphasis on envisioning, I have developed a mathematics curriculum model to implement creative and innovative pedagogies that help students gain access to much needed mathematical skills and knowledge required for critical and active citizenship…

My epistemology of research and professional practice are informed by multiple paradigms of educational research and philosophy, such as interpretivism, pragmatism, criticalism, post/modernism and integralism, to name a few. Unsurprisingly, I draw from self-study, Wisdom and Cultural Traditions, transformative education, various forms of imagination and inclusive logics to address otherwise unaddressed research issues, problems and agendas of mathematics education.

(Luitel, 2009)

to one's reader in educationally thoughtful ways. For example, in this paper I have create boxed texts juxtaposed strategically against the main text in order to illustrate an issue and/or provoke reflective thinking in the reader.

Critical auto|ethnographic research has become established in my research program as a powerful method for postgraduate students to engage in transformative professional development by: (i) examining critically their culturally situated educational experiences as students, teachers and teacher educators both at home and abroad, (ii) reconceptualising their shifting cultural identities and aspirations, and (iii) developing professional philosophies for rendering science and mathematics education inclusive of the everyday worldview practices - *beliefs, knowledge, values, languages, identities, games, relationships, experiential realities, taboos, dreamings* - that children in their countries bring into the classroom from their infinitely varied out-of-school lives.

Coda

Outcomes and processes of critical auto|ethnographic research studies conducted by the doctoral graduates mentioned in this paper are accessible in the following publications: Afonso, 2007; Afonso & Taylor, 2009; Cupane, 2007; Cupane & Taylor, 2010; Luitel, 2009, 2007; Luitel & Taylor, 2006, 2007, 2009. Copies of doctoral theses are downloadable from Curtin University of Technology Library: http://library.curtin.edu.au/

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i The concept of '**developing country**' is problematic because it can reinforce the Western modernist worldview which holds that in the natural order of things 'First World' nations (the West) serve as exemplary models of civilizing development in all domains of human life, including not only technology, industry and free market economics but also culture, language and religion.

ii The **Western modernist worldview** is a term used by postcolonial theorists and culture studies researchers to signify the assumed innate superiority of industrially developed nation states; historically taken to mean those of Western Europe where the Enlightenment (Scientific Revolution, Age of Reason) gave rise to the concept of

modernily in which the present is regarded as superior to the past. As European power spread with the discovery of 'the New World' this "translated into a sense of superiority over those pre-modern societies and cultures that were 'locked' in the past – primitive and uncivilised peoples whose subjugation and 'introduction' into modernity became the right and obligation of European powers" (Ashcroft, Griffiths & Tiffen, 2006, p.145). Also, West is capitalized to signify that the term serves as a metaphor for assumed cultural superiority and progress, rather than a geographical location; its origins lie in the European distinction between the Occident (West) and the Orient (East) which gave rise to the disempowering discourse of Orientalism as explained by Said.

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