

DEFROSTING AND RE-FROSTING THE IDEOLOGY OF PURE MATHEMATICS: AN INFUSION OF EASTERN-WESTERN PERSPECTIVES ON CONCEPTUALISING A SOCIALLY JUST MATHEMATICS EDUCATION

Bal Chandra Luitel & Peter Charles Taylor

Curtin University of Technology
<bcluitel(at)yahoo.com> and <P.Taylor(at)curtin.edu.au>

Abstract

Adopting a method of *writing as inquiry*, the paper deconstructs the overriding image of *mathematics as a body of pure knowledge*, thereby constructing an integral perspective of a socially just mathematics education in Nepal, a south Asian nation that is spiritually and historically rich and culturally and linguistically diverse. Combining a bricolage of storied, interpretive, reflective and poetic genres and an Integral philosophy, we envision a culturally contextualized mathematics education that is inclusive of Nepalese cultural, linguistic and spiritual diversities. This socially just mathematics education would enable Nepalese learners to: (a) co-generate mathematics from their cultural contexts; (b) connect their lived cultural experiences with formal mathematics and *vice versa*; (c) take up social, cultural and situated inquiry approaches to learning mathematics; and (d) solve real world problems by using different forms of mathematics.

Introduction

How can the notion of social justice be incorporated into mathematics education in Nepal? This question comes to my mind whilst I (Bal Chandra Luitel) begin to reflect upon my recent professional activities as a mathematics teacher educator, thereby generating a number of nodal moments that demonstrate how the dualist nature of *mathematics as a body of pure knowledge* together with an arid teacher-centred pedagogy causes prospective teachers to undergo painful learning experiences. Such events resonate with my experience as an undergraduate student who could neither find a meaningful link between mathematics and his lived experiences nor enjoy his mathematics classes (Luitel, 2003). Embedded in the school mathematics curriculum of Nepal, the image of 'pure' mathematics is likely to have contributed to the rampant underachievement of Nepali students in mathematics, as reported by recent national studies (Koirala & Acharya, 2005; Mathema & Bista, 2006). The major consequence of such a phenomenon is to disadvantage students from gaining better opportunities in their present and future lives. This case of gross social injustice has prompted us to write this paper as a means of unpacking social justice perspectives in mathematics education in Nepal, a rapidly modernizing southern Asian nation with a largely agrarian based economy, and a nation that is spiritually and historically rich and culturally and linguistically diverse (with over 92 distinct languages).

The paper emanates from my ongoing doctoral research that employs an arts-based auto/ethnographic method of inquiry so as to construct a culture-sensitive transformative philosophy of mathematics teacher education in Nepal. Auto/ethnography is characterised by the method of *writing as inquiry* which affords a performativity of self-culture dialectics and critical reflexivity, an approach that recognises the development of the researcher's subjectivity during the process of inquiry (Richardson & St. Pierre, 2005; Roth, 2005). In this method, writing is constitutive of the process of inquiry, rather than being an add-on activity performed on completion of the inquiry, and gives rise to an emergent research design not dissimilar to investigative journalism or novel writing. In this arts-based approach we employ the notion of data generation and perspectival visioning (Clough, 2002) via a bricolage of storied, interpretive and poetic genres and reflective 'interludes' located strategically throughout the paper.

In the writing as inquiry process, Peter and I have performed varying roles as co-constructors of this paper. Elsewhere we have used the metaphors of 'architect' and 'builder' to portray our co-generative writing roles (Taylor, Luitel, Tobin, & Desautels, in press). My primary role as builder-architect is to construct coherent texts whereas, as architect-builder, Peter reads critically and refashions my text, engages me in co-generative dialogue, and at times adds another brick to the wall. Of course, this dichotomy is somewhat simplistic inasmuch as the roles of builder and architect overlap and merge as we engage in the complex tasks of co-generative inquiry.

The paper begins with three semi-fictive cameos constructed on the basis of my experience as a mathematics teacher educator at the University of Himalaya¹ where I have been involved in developing and implementing a mathematics teacher education program that aims to produce secondary schoolteachers for Nepali schools. These cameos, which depict the image of *mathematics as a body of pure knowledge*, provide a basis for generating a hypercritical commentary incorporating three dimensions of social justice: recognition, inclusion and meaningfulness. In the first section, the commentary embodies an antithesis of the image of *mathematics as a body of pure knowledge*, a hitherto established view of mathematics that promotes a universalist agenda of mathematics as neutral in relation to cultural and political values. In the second section, a fictive dialogue ensues between me and three characters of the cameos as a means of generating synthesised perspectives about the nature of mathematics, inclusive pedagogy, meaningfulness of mathematics learning, and recognising non-Western knowledge traditions in mathematics education. This dialogue serves as an example of how we can rescue mathematics education from unhelpful social injustice promoting dualisms such as East versus West, content versus pedagogy, theory versus practice and knowledge versus activity.

Taking Integralism on board, the final section of the paper makes use of recent philosophical and political perspectives of education, historical-contextual information related to mathematics education in Nepal, and 'boxed poems' and dialectical reasoning as sources of integral vision making. Integralism derives mainly from Eastern wisdom traditions, such as Buddhism and Hinduism, and considers the

¹ I have used this pseudonym to protect the identity of my research participants associated with this institution.

process of knowing as organic, evolutionary and wisdom-oriented (Sri Aurobindo, 1952; Wilber, 2004) and dialectical (Wong, 2006). One of the many tenets of this philosophy is to emphasize the transformative synergy of inner self (Spirit) and exterior realities (Maya), thereby harnessing alternative logics of knowing, such as dialectical thinking, nondualism, metaphor and poetizing. Integral Philosophy (Wilber, 2004) is a referent for generating 'vision logic' to develop a socially justifiable mathematics education for Nepal.

Deconstructing the social injustice-laden myth of pure mathematics: An Antithesis

Cameo I

After completing postgraduate studies at an Australian university in 2003, I continue to work at the University of Himalaya where I am responsible for mathematics education programs in the Institute of Curriculum and Teaching. I have a strong desire to upgrade the one-year diploma program into a fully-fledged masters program specialising in mathematics education. Pondering several possibilities, I quickly write an application to the director attaching a proposal that explains the needs of a master's course in our institute. Next day, I am summoned by the director and find myself discussing several issues related to the proposed program. One of his questions puts me in a difficult situation. The question is similar to this: "Will the new program incorporate enough 'pure mathematics'?"

Cameo II

Now, the Subject Committee is formed. I am in a meeting with members of the committee. I present a structure of the proposed two year masters course. After the completion of my presentation, four members start making comments. "There is no Advanced Pure Math", says Member One. Immediately Member Two comments, "There should be a unit on scientific decision-making process in the course". Member Three's concern is on the proposed credit hour of Pure Math II, which according to him is not enough to teach its content. Whilst I am thinking about how to respond to these questions, Member Four's blunt comment, "What has sociology to do with a mathematics education course?", situates me in yet another dilemma.

Cameo III

The program is launched with 22 students. The students soon start feeling under the weather with two units, Pure Math I and Pure Math II. I start hearing that students are not satisfied with these units. Then, I meet with the unit tutors, and soon find them blaming students for being lazy, disrespectful, incompetent and unmathematical. Tutor One laughingly blames me for teaching them 'unmathematical stuff', such as philosophy, pedagogy and ethnomathematics. Tutor Two prefers his class to be mathematically oriented in which, perhaps, he does not entertain questions and interactions. What should I do? I start one-to-one consultations with students. Many of them point to the tutors' didactic pedagogy and the highly abstract nature of the subject matter as contributing factors to the dilemma situation. In the midst of this dilemma situation, one student raises a serious question. He asks me: "Why have you prescribed the units of *Pure Math I* and *Pure Math II*, which have no direct connection with our professional practice?". He further indicates that these units are not helping him to be a good mathematics teacher; rather they are contributing to his pain and suffering.

Interlude I



Now, what should I do with these cameos? My plan is to unpack the hegemonic nature of pure mathematics. Wait a minute! Am I going to be impressionistically critical? Yes, because I want to use a hypercritical genre (Van Maanen, 1988) so as to construct an antithesis to the thesis of pure mathematics being all-powerful and all-pervasive. Perhaps, this genre also partly shares the notion of a resistant reading which helps me (Faust, 1992) to interpret the cameos from the vantage point of my lived reality in which I experienced an unhelpful social hierarchy associated with the dominance of pure mathematics in Nepali mathematics education. Perhaps, my unfolding critique of pure mathematics can also be read from a subaltern perspective in order to compel readers to listen to the prevailing social injustice (Beverley, 2005).

Arriving at this juncture, I realise that Adorno's negative dialectic (Wong, 2006) is going to help me to 'discharge' a deconstructionist standpoint about pure mathematics. My hypercritical standpoint also garners support from Chinese dialectic that regards opposition as the precondition of changes (xiang-fan-xiang-yin; in Wong, 2006). And I gain insight from Shad-darshan (six Hindu schools of thought) (Radhakrishnan, 1927) that debates help me to generate understanding of the eternal². Therefore, this critical view of mine has privileged Yang over Ying, bibaad over baad³, and antithesis over synthesis. For now, please read it that way.

I shall navigate my journey of interpreting the three cameos by means of three dimensions of social justice: recognition, inclusion and meaningfulness. The concept of 'recognition' helps me to uncover the perpetual ideology of non-recognition of difference in the field of mathematics education. Indeed, the notion of recognition 'could involve upwardly revaluing disrespected identities and the cultural products of maligned groups. It could also involve recognising and positively valorising cultural diversity *within the field of mathematics education*' (Fraser, 1997, p. 5, emphasis added). The notion of 'inclusion' (Young, 2000) refers to the extent to which participation is ensured for all those who are affected by the process of discussion and decision-making in mathematics education. The idea of 'meaningfulness' (D'Ambrosio, 2006a; Luitel & Taylor, in press) is useful for considering the relevance and applicability of mathematics education in relation to the cultural lifeworlds of learners. In what follows, my unfolding interpretation of the three cameos aims to clarify pertinent issues of social justice in Nepali mathematics education.

Recognition

² वादे वादे जायते तत्त्वबोधः)Baade baade jaayate tatvabodha:(

³ Baad and bibaad are Sanskrit words and their English equivalent terms can be proponent and opponent respectively (see, <http://sanskritdocuments.org/dict/>).

There seems to be a dissonance between the metaphor of *mathematics as a pure body of knowledge* and the idea of recognising differences in mathematics education. The term ‘purity’, from both literal and metaphorical perspectives, appears to entail a notion of superiority, thereby involving students in following a rigid dogmatism. Can superiority and recognising others go together? In what follows, I argue that the othering discourse of pure mathematics seems to create an entanglement with other knowledge systems which entitles them as inferior, powerless and non-mathematical. I see the transmission of the message of *pure-mathematics-is-all-powerful* as undermining the inventiveness and emergence of cultural activities.

The problem deepens further as pure mathematics recognises only a particular knowledge system based in Westocentric ontology, epistemology and axiology (D'Ambrosio, 2006b; Taylor & Wallace, 2007). A question arises: Whose interest is being served by pure mathematics? It seems to me that *mathematics as a body of pure knowledge* promotes the twin myths of hard control and cold reason (Taylor, 1996) so as to camouflage the authentic image of mathematics as uncertain and unfolding human activity. By subscribing to uncertainty as an epistemic metaphor, we can facilitate learners becoming constructors of mathematics from their *own* lifeworlds. Where Skovsmose and Valero (2001) use the notion of ‘internalism’ to criticise the self-satisfying nature of mathematics education research, I use this concept to critique the dominant nature of pure mathematics that imposes a circular ‘self-justificatory system’ (Lerman, 1990) in an attempt to misrecognise the local, implicit and cultural nature of mathematics.

Pure mathematics seems to subscribe to a Platonist standpoint that regards mathematical knowledge as independent of the knower, leading to the notion that mathematics is an ideology-, culture-, and worldview-free subject. In an era of democracy, this perspective has major implications for the education of young men and women, amongst which is the concern that they may develop a narrow seemingly ideology-free view of the nature of mathematics. However, mathematics has never been free from ideologies (Gutstein, 2003); rather, it has developed from certain interpretive, linguistic and observational standpoints. It seems to me that depicting mathematics as an ideology-free subject has helped to colonise non-Western cultures through scientific, technological and educational interventions by materially rich Western countries (D' Ambrosio, 2006b). In a (World-Bank-defined) ‘developing’ country such as Nepal, importing pure mathematics from materially rich Western countries and then ‘stuffing’ it into students without due recognition of their cultural worldviews creates a chain of social injustices within the landscape of mathematics education (Luitel & Taylor, 2007).

Historians of mathematics (Boyer, 1968; Eves, 1983) point out that mathematical knowledge has not been developed overnight; rather it has been brought forward by human endeavours and then shaped by contemporary social, cultural and political factors. If pure mathematics used this historical insight to enhance its pedagogy there could be the possibility of recognising the different mathematical worlds of learners. However, by becoming the bastion of epistemic certainty, pure mathematics seems to ignore the historical contingency of mathematical knowledge. This ignorance of its own history further creates an illusion in which to see mathematical purity as extra-human, extra-cultural and extra-social. There is a high

chance that the image formed by the many ‘extras’ will continue to steer the discourse of mathematics education, thereby harbouring a pedagogy of non-recognition.

Inclusion

Let me start this section by referring to Cameo 3 in which a character, Tutor One, indicates that *his* pure mathematics is all-powerful, and that the students are not capable of *doing* this. The students are all mathematics graduates, and so I wonder from where and when on Earth pure mathematics might recruit its ideal students, those who are teachable according to the archaic philosophy of cultural reproduction (Bourdieu & Passeron, 1977) by which one reproduces an hierarchical, elitist, meritocratic and competitive culture of pure mathematics? Do the underlying notions of cultural reproduction and inclusion match? As ‘inclusion allows for maximum expression of interests, opinions, and perspectives relevant to the problems and issues’ (Young, 2000, p.23), the intention of instilling a dominating pedagogy of reproduction may cause inclusion not to flourish within the pedagogical landscape of pure mathematics.

Historically, the term ‘inclusion’ seems to have a close link with ‘special education’ in that inclusiveness refers to a non-segregated educational practice for differently able learners (Pickles, 2004). For me, the notion of inclusion refers to increasing the participation of all learners in mathematics, thus reducing the possibility of their exclusion from classroom activities. If I ask Tutor One and Tutor Two about how they might ensure that all students participate in *their* mathematics and how they might avoid the possibility of exclusion, they would likely answer that they need to find a way to make students listen attentively to their lectures, to rote memorise (oxymoron) theorems, to be present on their test days, and to submit their tutor-imposed assignments. Having taught according to the Logician-Formalist school, they may apply the ‘Excluded Middle Principle’ (Kline, 1980) so as to claim that there is no possibility of exclusion as they have already claimed students’ participation.

In defence of pure, formal and academic mathematics Rowland and Carson (2002; 2004) argue that mathematics represents an artificial cultural system that is independent of human culture. They seem to renew the defence of the canon of pure mathematics by shifting the age-old argument from *mathematics as a culture-free enterprise* to *mathematics as an artificial culture*. This new argument, however, seems to be a renewed interest in claiming pure mathematics to constitute a non-human culture. Does the metaphor of *mathematics as an artificial culture* permit more than technical participation of learners in the discourse of mathematics? Perhaps, the idea of artificiality seems to fit well with the idea of *technical* or *artificial participation* through lectures, assignments, narrowly-focused exams and so forth. Thus, there are few possibilities of moving forward to *practical participation* in which to emphasise the meaning-making enterprise of pure mathematical content. How about critical participation in the discourse of pure mathematics (Taylor & Campbell-Williams, 1993)? *Critical participation* entails situations in which learners can question the relevance of pure mathematics and its pedagogy to their teaching profession. However, it may be hard to marry the self-proclaimed purity of pure mathematics and critical participation of learners because criticality may be difficult to sustain within a closed and self-referential system.

In the quest for an inclusive mathematics education, I believe we need to recognize two types of exclusion, 'external' and 'internal' (Young, 2000). External exclusions are generally attributed to official decisions about curriculum, learning style, assessment and other issues that are directly concerned with students' well being. Internal exclusions may be subtle, and are generally caused by hidden curricula that are prevalent in sites of pedagogical enactment such as the mathematics classroom. For instance, although students are told that they can participate in the discourse of mathematics, only a select group may be able to fully participate because of a number of inhibitive factors, such as the low language proficiency of learners and nonrecognition of participation. Can mathematics as a body of pure knowledge be an appropriate metaphor for developing an inclusive pedagogy of mathematics education? I have strong doubts. Perhaps by embracing alternative metaphors, such as *mathematics as contingent, corrigible, fallible and an ever-developing knowledge system* (Ernest, 2006), we can pave the way for developing an inclusive pedagogy.

Meaningfulness

My recent reading of ethnomathematics, critical mathematics education and various forms of constructivism (Cobb, 1994; D'Ambrosio, 2006a; Ernest, 1997, 1994a; Glasersfeld, 1995; Skovsmose, 2005) gives me a sense that one of the many common aspirations is to enhance students' experience of meaningfulness in mathematics education. Ethnomathematicians argue that mathematics is a cultural and historical construct, and therefore it should be linked with the cultural practices of learners in order to make it meaningful according to their lifeworlds. Similarly, different constructivist perspectives emphasise a meaning-making pedagogy of mathematics. These perspectives, to varying degrees, allow learners to develop multiple standpoints on mathematical concepts, thereby internalising viable concepts through an active construction process. In particular, critical perspectives regard learners as ends-in-themselves rather than as objects to be manipulated as an instructional means for achieving something else.

The metaphor of *mathematics as a body of pure knowledge* tenders a vexing image representing the told and untold stories of meaningless mathematics (Luitel, 2003). Viewed from an ethnomathematical perspective, such a mathematics seems to impose on learners a fixed and culturally dislocated image. As the image of pure mathematics seems to subscribe to instructivist pedagogy, there may be few opportunities to afford learners opportunities to develop multiple sensibilities of mathematics or to engage actively in making meaning out of their daily lifeworld activities. Considering the idea of meaningfulness from the perspective of liberatory pedagogy (Freire, 1996) seems to lay emphasis on bolstering the individual learner's agency, thereby awakening them to understand their own socio-cultural valuing, becoming and being. Does pure mathematics allow learners to act as ends-in-themselves? Does it help widen learners' sense of being and valuing through their participation in mathematics learning?

The notion of the meaningfulness of mathematics seems to have links with its direct applicability to the cultural lifeworld of the learner. In saying so, I am aware that there are layered interpretations of key terms such as *applicability, lifeworld* and *learner*. The idea of applicability can be described as the extent to which mathematics is translatable to particular cultural contexts. The cultural context of application that I

am referring to is education, and thus the lifeworlds of learners constitute primarily schools and educational institutions. Now a couple of questions arise: Is pure mathematics applicable to the immediate lifeworlds of learners? In what follows, I briefly address this question.

Perhaps, it is not an over interpretation to argue that pure mathematics has little to say about the cultural realities of many people. Restivo (1994) argues that one of the main qualities of a good mathematician is the extent to which s/he is able to represent his/her mathematics abstractly. This can be put simply as: the more abstract the mathematics the higher the recognition as a mathematician. The emphasis on abstractness, the hidden rule of being incomprehensible by common people, and the convention of using symbolic language that has little relevance to day-to-day realities are key characteristics of pure mathematics (Restivo & Bauchspies, 2006). In totality, these characteristics convey the image that pure mathematics tries to dispel the cultural (Luitel & Taylor, 2007) and embodied (Nuñez, 2006) nature of knowing, thus endorsing a culturally dislocated mathematics education.

Interlude II



Peter's question, 'Do you want to deconstruct pure mathematics or the hegemony of pure mathematics?', causes me to think for a while. At this stage I think that I may be deconstructing both. Does this mean that I am rejecting pure mathematics? Can I maintain my personal sustainability by rejecting pure mathematics?

While writing the above commentary I felt that I was constantly agitating against pure mathematics. Does this mean that I am also writing against myself as some years back I was teaching a similar type of mathematics? Did I recognise students' ideas? Was I inclusive to all students? What strategies did I use to make pure mathematics meaningful? So what should I plan for? Perhaps I cannot live forever in a hypercritical world. This is as dangerous as the reclusive world of pure mathematics. I need alternative logics that can help me reconceptualise a balanced view of mathematics education in Nepal.

In the upcoming section, I use 'hyphen-logic' to defuse many unhelpful dichotomies. Perhaps, this is the stage of my attempting to know 'tatva', a Sanskrit word that means 'eternal truth'. You may notice that the following section helps me to synthesise Iam-notIam, Ying-Yang, Bad-Bibad, and thesis-antithesis in order to paint a holistic picture of a socially just mathematics education in Nepal.

Unpacking social justice perspectives through semi-fictive dialogues: A synthesis

Nurturing an inclusive mathematics education

Director: Throughout my career as an educational administrator, I held the belief that pure mathematics is universal and objective. Therefore, it has nothing to do with

politics, culture, day-to-day affairs or social justice. To me, there is a danger of your critical standpoints being interpreted as idiosyncratic rather than social justice-oriented.

Bal Chandra: One can hold the view that mathematics is an ‘objective’ and ‘universal’ knowledge system, however, my concern is that this is not recognised as *a view*; rather it has served as *the only view* of mathematics in the educational landscape of Nepal. Although I agree that earlier in this paper I was too critical of pure mathematics, some aspects of my critique mirror, perhaps, prevailing unhelpful dichotomies of *pure* versus *impure* mathematics, *hard* versus *soft* mathematics, *Western* versus *local mathematics*, *content* versus *pedagogy* mathematics. Perhaps holding an historical view that mathematics evolves through different historical, cultural and political junctures can help us to achieve a balance between such dichotomies. A developmental synthesis can be foreseen by providing learners with an epistemic context in which different natures of mathematics co-exist and co-interact.

Tutor One: First of all, I am surprised that you choose the issue of social justice in mathematics education. This issue is overly political, thus it has nothing to do with the mathematics I teach. Do you think that your overly critical approach helps teachers to be aware of social justice?

Bal Chandra: At some stage in my thinking, the vantage point of a critical perspective helped me to understand social phenomena as constitutive of power relationships. This can be useful for viewing pedagogical activities as an enactment of power relationships amongst different stakeholders. For instance, the existing power relationships between mathematics teacher and students can be oppressive to students because of the prevailing teacher-centred pedagogy in Nepal. However, I acknowledge that this perspective often promotes an unhelpful oppressor-oppressed dichotomy. Perhaps, it is worth exploring an alternative perspective that regards teaching as a desire-less, selfless and compassionate (Sri Aurobindo, 1952) act in which to devote one’s professional life to the wellbeing of the other. And more so, perhaps an approach that combines both views, *teaching as a self-less act* and *teaching as a political act*, can help promote a socially just mathematics education in Nepal. As a teacher I can act selflessly and compassionately whilst, at the same time, being aware of the possibility of power misuse by me during my pedagogical enactment.

Tutor Two: If you acknowledge that there are disciplines then you need to understand that they have agreed upon standards of what counts as knowledge. Pure mathematics is not an exception. While taking social justice on board, you could argue that teaching powerful ideas of pure mathematics could empower prospective teachers and then their future students. Because if the prospective teachers understand theorems, definitions and mathematical problems, they can teach mathematics to their students more effectively. In this way social justice would prosper as a result of mathematics education.

Bal Chandra: I accept the fact that different branches of mathematics have been unified according to their respective standards. At times, however, these standards are contested, questioned, and reformulated (Ernest, 1994a, 1994b). This does not mean

that *all* such standards are changed to the same degree; rather the varying degrees of change, from minimal modification to total replacement, is a possibility.

I agree with your view that provisions for exploring many powerful ideas of mathematics are desirable in order to enhance rich and sustainable understanding of the world lived in by learners. Although I acknowledge the importance of pure mathematics in providing us with rules, patterns and structures, I beg to offer an inclusive view that powerful mathematical ideas emanate from our day-to-day lifeworlds and cultural activities. Perhaps, this view also gives room to pure mathematics to provide learners with discursive opportunities to search for meaningful and sustainable mathematical ideas.

What can be the salient features of such powerful mathematical ideas? I envision them to be: (a) adaptable to the cultural realities of learners, (b) useful for enhancing rich understandings of social and cultural phenomenon, (c) meaningful for each learner according to his/her needs and interests, and (d) emancipatory for learners' development of critical understandings of themselves and the world around them. Perhaps an inclusive view of (mathematics) intelligence that takes into account different modes of thinking and acting practised by the linguistically and culturally diverse Nepali population would help to formulate a compatible framework for assessment of such powerful mathematical ideas (Sternberg, 2007).

I find that *mathematics as cultural activity* is a more inclusive image than foundationalist metaphors such as *mathematics as a body of knowledge* and *mathematics as a culture-free enterprise*. Perhaps by enacting a cultural activity metaphor we can offer an alternative view that mathematical theorems, definitions and problems are human constructions in which to celebrate differing natures of mathematics.

Developing a recognition-oriented pedagogy

Director: While interpreting your stories from social justice perspectives, you have identified an interesting dimension of recognition. In what follows, you argue that pure mathematics is very weak in recognising others, thereby creating an socially unjust pedagogy of mathematics education. This idea seems to be very philosophical. What is your vision for bringing the idea of recognition into pedagogical practice?

Bal Chandra: I have benefited greatly from following an ongoing philosophical debate about the nature of mathematics (Ernest, 1991; Hersh, 1997; Lakoff & Núñez, 2000). Such debates have unpacked different views of mathematics such as *mathematics as metaphorical embodiment*, *human activity*, and *invented knowledge*. As an educator, I believe that philosophical debates offer ways to develop a comprehensive vision for developing a social justice oriented mathematics education in Nepal. Perhaps the use of different philosophical referents is indicative of an imminent global recognition of different viewpoints about mathematics. There may be a critical view that pure mathematics is elitist and non-recognisant whereas an opposing view asserts that pure mathematics is useful for developing analytic-speculative reasoning. But can we afford to live by a single viewpoint? Perhaps we need to be cognisant of these differing views in order to instil a recognition-oriented pedagogy of mathematics.

What might the mathematics education landscape of Nepal look like when a recognition-oriented pedagogy is incorporated? Perhaps we would see: (a) mathematics teachers developing the sensibility that they need to respect students' ideas; (b) members of curriculum committees recognising that there are alternative knowledge systems that should be included in mathematics curricula; and (c) mathematics teacher educators providing prospective mathematics teachers with an authentic experience of this pedagogical tool. Beside this, I envisage that the notion of recognition as a pedagogical referent can be helpful for conceptualising a multicentric pedagogy in which each student can develop the feeling of being valued and acknowledged.

Tutor One: I also have a problem with the term *recognition*. I think you are trying to create a utopia in which all students have different mathematics and will enjoy a 'whatever goes' mathematics. This kind of social justice may dumb down the students.

Bal Chandra: I see two antithetical worlds evolving in the hypercritical genre that I used earlier to interpret my cameos. The world of pure mathematics appears to be the promoter of social injustice in the mathematics education of Nepal while the hypercritical world seems to reject the presence of pure mathematics thereby promoting a utopic view of mathematics. Now, it seems to me that both views, *mathematics as a body of knowledge* and its alternative critique constitute a dualistic tendency of avoiding the other. How is it possible to develop an encompassing alternative that recognises both views?

Perhaps, a synergy that amends the current monological mathematics pedagogy by recognising alternative natures of mathematics is inevitable. It also would help to be open to the emergence of different mathematical knowledge systems that are prevalent in the diverse linguistic and cultural landscapes of Nepal. Instilling a recognition-oriented pedagogy can help learners to become aware of their agency. I further envisage that a helpful synthesis of *mathematics as a pure fixed knowledge system* and *mathematics as cultural activity* can be represented by *mathematics as mediated social discourse* which gives rise to multiple forms of mathematics. Perhaps, enacting multiple mathematical discourses will eventually reinforce *mathematical literacy*, a key component of students becoming a responsible citizenry.

Tutor Two: You state that pure mathematics enforces its own way of validating a single form of knowledge through enculturation. I am particularly anxious about your framework of social justice which seems to demean mathematical enculturation by means of which we develop mathematical thinking among students. To get rid of mathematical enculturation we need to stop teaching pure mathematics, which I think is suicidal to the future of mathematics education. The more effective the mathematical enculturation the better the mathematical thinking. I will subscribe to this type of social justice rather than demeaning the power of pure mathematics.

Bal Chandra: I cannot deny some degree of enculturation in mathematics education. However, we also need to be aware of pure mathematics unhelpful emphasis on enculturation as one-way cultural border crossing. The prevailing practice of enculturation seems to have more demerits than merits, particularly when the aim is to change students' beliefs rather than promote multiple (sometimes contradictory)

conceptual understandings. Perhaps an inclusive alternative to enculturation is *acculturation* (Taylor & Cobern, 1998) which ‘comprehends those phenomena which result when groups of individuals having different cultures come into continuous first-hand contact, with subsequent changes in the original culture patterns of either or both groups’ (Redfield, Linton, & Herskovits, 1936, p. 49).

One of the benefits of acculturation is being inclusive of some aspects of enculturation. For instance, when two students share their differing views of a mathematical concept they need a language that is shared by both. The substantial focus of acculturation, which is on crossing multiple cultural borders, seems to promote a progressive form of enculturation which raises awareness of mainstream interpretations of mathematical concepts as well as their limitations. I think that subscribing to acculturation as a pedagogical referent would enrich mathematical thinking among learners. Would this not help to enhance the rigour of mathematics?

Enacting pedagogical inclusion through Integralism

Tutor One: While talking about the social justice dimension of inclusion, you have criticised conventional educational activities such as lecturing, presentations, exams and assignments. I think we need a framework with which we can help students to develop correct understandings of pure mathematics. Does your social justice framework regard lecturing, tutor-made assignments and exams as sources of social injustice?

Bal Chandra: Perhaps multiple pedagogical referents are appropriate for addressing the diverse needs of students. By using metonymical representations, such as *teaching as lecturing*, *assessment as probing*, and *students as object*, we have narrowly reduced the purpose of education to passing an exam. Indeed, there is nothing wrong with lecturing as long as it is a pedagogical means to a socially just end, rather than serving as an end in itself. Perhaps by using integralism as a pedagogical referent for promoting inclusivity we can unite the spiritual (Inner) and worldly (Outer) realities of the learner.

The antithesis that tutor-made assignments are a source of social injustice has some merit inasmuch as tutors may be habituated to using a one-size-fits-all approach to assessing students. However, offering only an ideological critique may not solve the problem. Perhaps a developmental assessment approach that also considers ‘contextual intelligence’ (Sternberg, 2007) can promote participatory, teacher-student mediated, explanatory and learner-owned pedagogies in mathematics education.

Tutor Two: I have a problem with making sense of your different modes of participation. It is clear that you do not like technical participation in which students gain mastery of mathematical concepts, mathematical proofs and mathematical problem solving. Your second preferred mode of practical participation does not help without students firstly knowing the basic knowledge and skills of pure mathematics because the making of meaning cannot be accomplished without fundamental ideas of the discipline. In what follows from your writing, critical participation seems to provide a space for being critical about the subject they study. I think this is a very awkward formulation because students are not capable of critiquing the subject matter until they develop a high level of expertise in mathematics.

Bal Chandra: It may appear in my discussion that the three modes of participation – technical, practical, critical – are hierarchical and thus separate from each other.

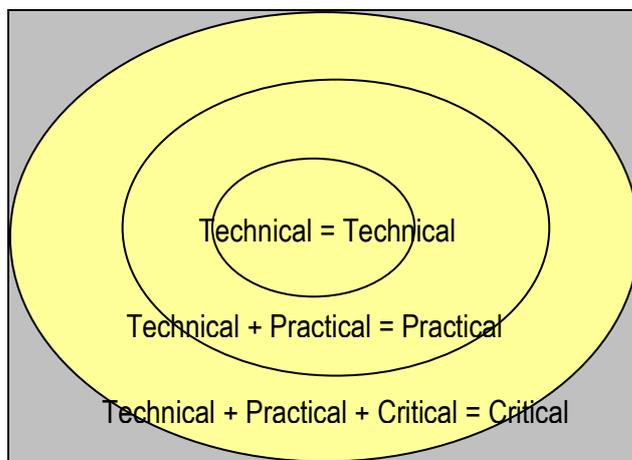


Figure 1: A *holarchy* of three modes of participation

However, my intention is instead to explain relationships between the three modes of participation by means of the concept of ‘holarchy’ which helps reformulate mistakenly conceptualised hierarchies by using the notion of holism (Wilber, 1996). In what follows, technical participation is the basic element, with other modes of participation being embraced successively (see Fig. 1). I am critical of *mere* technical participation of

learners because it seems to focus solely on one-way cultural border crossing. Given the nature of holarchy, practical participation is inclusive of technical participation. Similarly critical participation is inclusive of technical and practical modes of participation. I do not think that critical participation is only the business of experts in mathematics; rather it can help students to be aware of their *own* false consciousness about the nature of mathematics being studied. Perhaps employing the notion of holarchy would help change our perception of these three modes of participation from ordered and hierarchical to developmental and interactive. Employing technical participation alone can be imposing while combining its use inclusive with other modes of participation can be empowering.

Meaningfulness for social justice

Director: I have not seen that much of a direct relationship between meaningfulness and social justice. Do you intend to say that *every mathematics* we teach in school should be applicable to the immediate lifeworlds of the learners? If so, you have narrowly defined the notion of meaningfulness. I do not think that whatever we teach today should be totally applicable to their immediate world. Delimiting everything to learners’ day-to-day realities may not address the future aims of education. To me the notion of meaningfulness needs to be interpreted from a broad vision which is capable of prescribing ‘future mathematics’ that prospective teachers will eventually use in their teaching.

Bal Chandra: Although meaningful mathematics can empower learners by helping them to make sense of their lifeworlds through mathematical concepts this, however, is not to subscribe to the view that we should stop thinking about the future. It would be helpful to consider the present-future dialectic; what is in the present can also be part of the future and what is not today can be a basis of what will constitute the future. I find it helpful to consider the present and future not as separate entities but as always being connected. Given the dialectical relationship between present and future, it is important that we consider *education as life* (Dewey, 1943) rather than preparation for life. By employing the *education as life* metaphor we start to think

about the type of mathematics that is useful for learners' unfolding lifeworlds. Does this not solve the present-future dichotomy embedded in our conventional conceptualisation of mathematics?

Tutor One: I like the notion of meaningfulness which tends to imply the applicability of mathematics to one's immediate lifeworld. However, I would argue it differently. Mathematical meanings are very powerful and learners can get them only when they are richly acquainted with enough of the content knowledge of mathematics. How can a learner realise, for example, that Roll's theorem⁴ can be applied to find the maximum height of an undulating mountain without actually being exposed sufficiently to Roll's theorem? In order to be able to apply any such theorem students need to understand correctly the fundamentals of pure mathematics.

Bal Chandra: You seem to subscribe to the view that meaningfulness is achieved only after being adequately exposed to the subject matter of mathematics. An antithesis of this view is that the subject matter unfolds after a relevant activity grounded in the learners' lifeworlds. The conventional idea of privileging subject matter has some merits, such as (a) the subject matter can be a guiding tool for learning, and (b) learners can benefit from having an advance organiser before starting a mathematical application. On the other hand, starting mathematics through an activity grounded in the learner's context can be empowering for them as they start mathematising contextual problems, thereby generating meaningful mathematical knowledge. Which pedagogical approach can enhance such a notion of meaningfulness in mathematics? Perhaps an approach that promotes interaction between algorithmic-deductive (subject matter first) and contextual-inductive (activity first) in which learners use both approaches thereby complementing the inefficiency of one by the effectiveness of the other. For instance, perhaps starting with a contextual problem, then making links with Roll's and other theorems, and then making several backwards and forwards movements between theorems (subject matter) and contextual problems, can help make Roll's theorem more fully meaningful to learners.

Tutor Two: While discussing the notion of meaningfulness we need to remind ourselves that pure mathematics has the power to differentiate mathematical and non-mathematical objects, concepts and problems. Mathematically, applicability can be interpreted as the power of recognising and applying appropriate mathematical ideas. What do you think about this?

Bal Chandra: An antithesis of *some-phenomena-can-be-more-mathematical-than-others* is that categories such as mathematics and non-mathematics constitute our contingent forestructures. Some aspects of this antithesis help us to be open about the emerging and evolving nature of mathematical knowledge. When some aspects of emergence are incorporated into mathematics pedagogy learners can benefit by the underlying metaphor of *mathematics as somewhat open inquiry*.

How and when is the power of mathematics demonstrated? One view is that mathematical power is demonstrated by solving algorithmic problems of mathematics. In this model students need to gain a mastery of the technical knowledge of pure

⁴ Roll's theorem can be stated as: If $f(a) = f(b) = 0$ then $f'(x) = 0$ for some x with $a \leq x \leq b$.

mathematics before applying it. Alternatively, students can be provided with rich contexts in which to explore (pure) mathematical ideas through contextualised activities such as social inquiry, collaborative projects, and other culturally-situated actions. Perhaps these contextualised activities can help students develop multiple sensibilities of mathematical concepts thereby helping them to realise the power of mathematics-in-the-making.

Interlude II



By using dialectical thinking I have attempted thus far to develop an inclusive social epistemology and pedagogy of mathematics, particularly for teacher education. This 'hyphen logic' now leads me to incorporating 'vision logic' and 'poetic logic' with which to see into the present-future in a way that regards both categories as One, just like a full day comprises day and night. This juncture is crucial for me because I need to think about how the upcoming section will emerge.

My recent readings of Aurobindo, Shantideva and the I Ching encourage me to use the power of poetic thinking to explain the unexplainable. As the popular saying goes, 'a poem reaches beyond the sunrays⁵', I also find Sama Veda, one of the Vedic sacred epics, promoting poetic thinking as important as other types of thinking⁶. These poems can be read as my layer of thinking which is hard to unpack by means of a straight sentence writing style.

Enacting social justice via culturally contextualised mathematics education

The popular Nepali adage, 'Don't forget your soil', is worth mentioning here as we attempt to make connections between Nepali spirituality and the notion of a culturally contextualised mathematics education. The soil metaphor gives a sense of identity, worldview and cultural activities of people situated in a particular context. Elsewhere (Luitel & Taylor, in press; Luitel & Taylor, 2005, Apr; Taylor et al., in press) we have discussed ways in which mathematics education in Nepal can start to *remember its soil* and begin to address the outstanding problem of gross underachievement and exclusion in mathematics education. In this paper we renew our vision of culturally contextualised mathematics education in Nepal, and extend it in relation to the notion of social justice. In the process we have anticipated a number of questions being directed to us: Which perspectives and theories are behind the notion of contextualisation? How does contextualised mathematics education reconcile with conventional mathematics education? In what ways does the idea of contextualisation promote social justice in mathematics education? In what follows, we try to explore possible answers to these and other evolving questions, thereby further crystallising our idea of contextualised mathematics education.

⁵ जहाँ पुग्दैनन रवी त्यहाँ पुग्छन कवी !

⁶ A translation of Sama Veda is available at <http://www.sacred-texts.com/hin/sv.htm>

... *philosophically speaking*

In the last three decades, we have witnessed an upsurge of educational philosophies giving rise to new visions of how to improve the outstanding problems of education. In this process, radical constructivism, social constructivism and social constructionism have emerged to redefine the conventional knowledge system and propose new sets of knowledge standards. In so doing they have critiqued the long-standing Platonist view of mathematics and offered exciting possibilities for mending injuries caused by earlier foundational philosophies. These alternative philosophies tend to offer an inclusive pedagogical practice with which to enrich learning through continuous, developmental and authentic assessment approaches.

More than that, the post-epistemological nature of radical constructivism has opened up a powerful new framework of 'viability' by means of which the mathematical knowledge system can be explained as temporal, situated and experiential. Social constructivism has challenged the foundational philosophies, refining further Lakatosian quasi-empiricism and offering alternative metaphors to represent the nature of mathematics: *mathematics as a dialogic, fallible, corrigible and socially constructed knowledge system* (Ernest, 1994). And, in recent years, social constructionism has challenged the basic conventional assumption of knowing as a dualistic enterprise and posited the notion of knowing as constructing the world through social artifacts, 'products of historically situated interchanges among people' (Gergen, 1985, p. 267). To construct mathematical knowledge according to this perspective requires a cooperative enterprise in which to consider the multiple historical and cultural bases of the knower in relationship with 'the other'. In such a situation different mathematical knowledge systems are validated through the vicissitudes of social process that are based largely on the cultural practices that are shared by people-in-relationships.

... *politically speaking*

In critiquing the overriding conventional view of culture-free mathematics D'Ambrosio (2007) argues that modern mathematics has been a means of oppression. His rescue mission, *program ethnomathematics*, is influenced by the work of Paulo Freire (1996) who has been regarded as the champion of liberatory pedagogy. Whereas much of Freire's work has been situated in the field of adult literacy, D'Ambrosio (1999) makes a case against the widespread cultural deprivation perpetrated by Westernised mathematics. D'Ambrosio's (2007, p. 179) *program ethnomathematics* contributes to "restoring cultural dignity and offers the intellectual tools for the exercise of citizenship". We feel a solidarity with D'Ambrosio to the

Poetically speaking

*By the help of 'that'
I explain 'this'
Fusing this and that
I generate a vision of thisthat.*

*Thisthat is not this
Because it has that within it.
Thisthat is not that
Because it has this within it.*

*Thisthat is also this
Because it is inclusive of that
Thisthat is also that
Because it is inclusive of this.*

*I start with two: this versus that
I make three: this, thisthat and that
Finally I come to one: the spirit
which helps me to be inclusive.*

extent that his view of ethnomathematics offers an inclusive vision of mathematics education in Nepal.

Critical mathematics education is also useful for examining the empowering and disempowering roles of mathematics education (Skovsmose, 2005) in Nepali society. It offers a critical view of how formal/academic mathematics is responsible for perpetuating through conventional mathematics education a hierarchical social structure. The *apartheid* education system of South Africa can be considered to be a visible example of how academic mathematics, together with other political influences, became a tool of segregation and oppression (Khuzwayo, 1998). In a similar vein, concerns about the introduction of ethnomathematically inspired pedagogical approaches in mathematics education have been raised. It is argued that if ethnomathematics is used as the sole pedagogical referent for mathematics education, learners' would become alienated from conventional mathematics and lose access to social choices which arise from developing this knowledge (Vithal & Skovsmose, 1997). We are sympathetic to this concern because we believe that history demonstrates clearly that the imposition of a single nature/referent/mode of mathematics education has not catered well to the needs of a culturally diverse Nepali population. A narrowly conceived mathematics education, whether it be conventional or radical, is likely to fail to enable learners to cross multiple mathematical (and cultural) borders, thereby restricting development of their lifeworlds.

... contextually speaking

The widespread underachievement in mathematics in Nepal is evident as more than 60% of the students fail each year in mathematics in the national exam of School Leaving Certificate (SLC) (Mathema & Bista, 2006). Similarly, a number of national studies have shown general underachievement and poor participation rates of pupils in mathematics at the primary level ((EDSC, 1997, 2003). The status of female students is worse: a recent UNESCO-initiated study (Koirala & Acharya, 2005) found that Nepalese girls' achievement in school mathematics is consistently below that of boys.

A brief historical perspective can help interpret the phenomenon. It is interesting to

note that formal education in Nepal started initially with the blind importation of a British model in 1853. Although there was only one school and it catered to the ruling class, the Rana and Shaha families, present day education in Nepal seems to have followed in the same footsteps by continuing to import blindly education and curriculum models from materially rich counties of the North and the West. However, the methods and modes of importation have changed in different historical periods. Until the 1950s, Nepal relied on foreign textbooks, teachers, examination boards and affiliating bodies. After the 1970s, Nepali education entered into a new phase of

importing educational 'software' and 'hardware', by swinging back and forth as per the interest of politicians, bureaucrats and donors. In this process, a culture deficit theory seems to have prevailed in justifying the importation of education and curriculum models. This is not to say that we should stop learning from others' experiences. Intercontextual and intercultural transferability can be an alternative to this blind importation.

Another reading of Nepali history generates a positive image of growth in which the literacy rate has risen to about 55%, almost every Village Development Committee has at least one school, the small country has five functional universities, a significant number of professionals are produced within the country, and a realisation that education should be grounded in day-to-day realities (mainly language) of the learner is becoming pertinent. However, these questions arise: Is this educational growth distributed evenly amongst the population? To what extent has rural Nepal benefited from this growth?

Poetically speaking

*What is history?
Perhaps a ~~h~~istory
That has been ~~h~~istor^{ed}_y
In our lifeworlds*

*Multiple ways of telling-
verse, prose, song and dance
Different voices of reading-
Responsive, resistant and dialogical*

*History flows as though a river
Changing its pathways with floods and streams
Some worship the river
for bringing hope to them
Some term it a devil for causing all sorts of
pain
Some see themselves as the source of the
problem
Not the river.*

Given these historical realities, Nepali mathematics education remains foreign to most Nepali students even for those who are performing well (Luitel, 2003). Perhaps, the influence of blindly imported mathematics curriculum and textbooks continues to bolster an image of *mathematics as a body of knowledge*, thereby undermining otherwise progressive images of mathematics such as *mathematics as cultural activity*. Perhaps, the overriding influence of pure mathematics in mathematics pedagogy, together with a narrowly conceptualised notion of *assessment as an add-on activity to teaching*, has fuelled the existing problem of underachievement.

... *dialectically speaking*

In what ways will a culturally contextualised mathematics education be different from the existing conventional mathematics education in Nepal? Perhaps first it is important to discuss the notion of culture. Metaphorically, culture can be understood as artefacts, schema, refinements, cultivation, human activities, or a production site of meaning (Schech & Haggis, 2000). Owing to the limitation of any particular metaphorical image, we conceptualise culture in terms of a range of dialectical pairs: consciousness|representation, artefacts|meanings, schema|activities, and reification|enactment⁷. Metaphorically, the symbol for *Nand* (\wedge) represents a dynamic synthesis of opposing pairs as a means of developing holism. Each dialectical pair represents a recursive relationship between the two adversaries, at times producing internal contradictions and complementation whilst maintaining an evolving coherent system. This dialectical perspective helps us to generate a view that culture never remains unchanged, rather it is always in flux, offering a forestructure for viewing and interpreting the complexity of the world. Similarly, drawing on the Sanskrit equivalent of culture, *sanskriti*, gives us a meaning for culture as involving a constant refinement of our actions.

Poetically speaking

\wedge is neither this.
Therefore \wedge is not that.
 \wedge is here.
Therefore \wedge is there.
 \wedge is not here.
Therefore \wedge is not there.
 \wedge is this and that.
 \wedge is here and there.

This co-exists with that.
Here makes sense of there.
Yes exists because of no.
 \wedge makes sense of $\sim \wedge$.
'I am' because 'I am not'

In employing this dialectical perspective a mosaic of multiple natures of mathematics forms in our discursive landscape. In this process, we realise that the notion of dualism does not fit well as a theoretical referent because of its inability to explain the enactment of a complex mosaic of multiple mathematical natures. By contrast, our nondualist-integral perspective (Sri Aurobindo, 1998; Wilber, 2004) helps to dispel many unhelpful dichotomies, such as mathematics versus culture, knowledge versus activity, and meaning versus interpretation. In the dialectical process of reconceptualising mathematics, alternative natures of mathematics, such as *mathematics as activity*, *mathematics as informal problem solving*, *mathematics as socio-cultural enactment*, and *mathematics as cultural meaning-making*, combine to build a synergy with the conventional nature of *mathematics as a body of decontextualised pure knowledge*. By imagining

⁷ ' \wedge ' represents a logical operator that consists of a logical AND followed by a logical NOT and returns a false value only if both operands are true.

mathematics as both a noun and a verb the possibility of mathematics education being dominated by the conventional image of *mathematics as a decontextualised body of pure knowledge* greatly reduces. With such a complex image of contextualised mathematics education the cultural lifeworlds of learners can more readily interact with mathematics, thereby bringing their cultural capital to the forefront.

How might Nepali teachers and students act in a culturally contextualised mathematics education? The teacher would strive to recognise students' cultural and individual differences, promote inclusive participation of students, and create caring and collaborative learning environments; thereby promoting meaningful mathematical acculturation according to which students would often engage in crossing and recrossing the borders of local and formal mathematics. Engaged in exploring connections between formal and local (village or street) mathematics, Nepali students would be seen (a) co-generating mathematics from their cultural contexts; (b) linking their cultural experiences with formal mathematics; (c) taking up social inquiry, project, and cultural inquiry approaches to learning mathematics; (d) developing local classifications of mathematical ideas, based on their uses in local cultural contexts; and (e) solving real world problems by using different forms of mathematics.

Interlude III



I have arrived at the end of this journey. The journey with many detours and different stopping points has proved to be adventurous. Knowingly or unknowingly I seem to have been guided by the idea of a proscriptive logic which says: "This is what's forbidden; everything else is allowed" (Davis & Simmt, 2003, p. 147). This act of depicting complexity seems to be as old as the early Vedic and Buddhist poets who wrote about the Shunya, the Pancha Tatva, the Mokshya and the Nirvana. I (and ~I) am in a crisis of representation. Sounds, alphabet, words and sentences seem to be ceasing to the One that is characterised by emptiness. What is that which is not empty? The beginning is empty so is the end. Perhaps, I have arrived at a new beginning.

Concluding for now

Given the seemingly adversarial metaphors of mathematics *as a body of pure knowledge* and mathematics as *cultural activity*, mathematics education in Nepal requires a social justice oriented transformation that produces an inclusive image of mathematics education. Given the cultural, lingual and spiritual diversities of Nepal, a credible approach to incorporating social justice in mathematics education is to implement a culturally contextualised mathematics education which integrates multiple natures of mathematics, thereby opening room for celebrating not just deductive-analytic logic but also others, such as dialectical and poetic logics, that have been preserved by wisdom traditions of the East and West. The transformative image of culturally contextualised mathematics education can be a healing metaphor for Nepali mathematics education because it promotes a recognition-oriented epistemology, an inclusive view of mathematics, and a meaningful pedagogy. By

enacting such a transformative vision of mathematics education, we would likely witness: (a) Nepali teachers and students working collaboratively to construct mathematics from their cultural sites, (b) Nepali teacher educators and teachers embarking on a journey of exploring culturally contextualised pedagogical tools in mathematics, (c) Nepali mathematicians and teacher educators setting up a new venture to explore different mathematical practices (and logics) of diverse Nepali communities, (d) other stakeholders of the Nepali education system being committed to adhering to the notion of social justice in mathematics education.

List of references

- Beverley, J. (2005). *Tenstimonio*, subalternity and narrative authority. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 547-557). Thousand Oaks: Sage Publications.
- Bourdieu, P., & Passeron, J.-C. (1977). *Reproduction in education, society, and culture*. Beverly Hills, CA: Sage.
- Boyer, C. B. (1968). *A history of mathematics*. New York: Wiley.
- Clough, P. (2002). *Narratives and fictions in educational research*. Buckingham: Open University Press.
- Cobb, P. (1994). Where is the mind? Constructivist and sociocultural perspectives on mathematical development. *Educational Researcher*, 23(7), 13-20.
- D'Ambrosio, U. (1999). Literacy, matheracy, and technocracy: a trivium for today. *Mathematical Thinking and Learning*, 1(2), 131-153.
- D'Ambrosio, U. (2006a). *Ethnomathematics: Link between traditions and modernity*. Rotterdam: Sense Pub.
- D'Ambrosio, U. (2006b). The Program Ethnomathematics: A theoretical basis of the dynamics of intra-cultural encounters. *Journal of Mathematics and Culture*, 1(1), 1-7.
- D'Ambrosio, U. (2007). The role of mathematics in educational systems. *ZDM*, 39(1), 173-181.
- Davis, B., & Simmt, E. (2003). Understanding learning systems: Mathematics education and complexity science. *Journal for Research in Mathematics Education*, 34(2), 137-167.
- Dewey, J. (1943). *The school and society*. Chicago: University of Chicago Press.
- EDSC. (1997). *National achievement level of grade three students*. Kathmandu: Educational Development Service Centre.
- EDSC. (2003). *National achievement level of grade five students*. Kathmandu: Educational Development Service Centre.
- Ernest, P. (1991). *The philosophy of mathematics education*. London: Falmer Press.
- Ernest, P. (2006). Nominalism and conventionalism in social constructivism. *Philosophy of Mathematics Education Journal*, 19, Downloadable from: <http://www.people.ex.ac.uk/PErnest/pome19/index.htm>.
- Ernest, P. (Ed.). (1994a). *Constructing mathematical knowledge: Epistemology and mathematics education*. London.: Falmer Press.
- Ernest, P. (Ed.). (1994b). *Mathematics, education, and philosophy: An international perspective*. London: Falmer Press.
- Eves, H. (1983). *An introduction to the history of mathematics*. New York: CBS College. .
- Faust, M. A. (1992). Ways of reading and "The Use of Force". *The English Journal*, 81(7), 44-49.

- Fraser, N. (1997). *Justice interrupts: critical reflections on the "postsocialist" condition*. New York: Routledge.
- Freire, P. (1996). *Pedagogy of the oppressed* (New rev. ed.). London: Penguin.
- Gergen, K. J. (1985). The social constructionist movement in modern psychology. *American Psychologist*, 40(3), 266-275.
- Glaserfeld, E. v. (1995). *Radical constructivism: A way of knowing and learning*. London: Falmer Press.
- Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education*, 34(1), 37-73.
- Hersh, R. (1997). *What is mathematics, really?* New York: Oxford University Press.
- Khuzwayo, H. (1998). "Occupation of our Minds": A dominant feature in mathematics education in South Africa. In P. Gates (Ed.), *Conference proceedings of the First International Mathematics Education and Society* (pp. 219-231). Nottingham: Centre for the Study of Mathematics Education.
- Kline, M. (1980). *Mathematics : The loss of certainty*. New York: Oxford University Press.
- Koirala, B. N., & Acharya, S. (2005). *Girls in science and technology education: A study on access and performance of girls in Nepal*. Kathmandu: UNESCO.
- Lakoff, G., & Núñez, R. E. (2000). *Where mathematics comes from: How the embodied mind brings mathematics into being* (1st ed.). New York, NY: Basic Books.
- Lerman, S. (1990). Alternative perspectives of the nature of mathematics and their influence on the teaching of mathematics. *British Educational Research Journal*, 16(1), 53-61.
- Luitel, B. C. (2003). *Narrative explorations of Nepali mathematics curriculum landscapes: An epic journey* Unpublished Master's Project, Curtin University of Technology, Perth: Downloadable from <http://pctaylor.com>
- Luitel, B. C., & Taylor, P. (in press). The shanai, the pseudosphere and other imaginings: Envisioning culturally contextualised mathematics education *Cultural Studies of Science Education* 2(3).
- Luitel, B. C., & Taylor, P. C. (2005, Apr). *Overcoming culturally dislocated curricula in a transitional society: An autoethnographic journey towards pragmatic wisdom*. Paper presented at the annual meeting of the American Educational Research Association (AERA), Montreal, Quebec.
- Mathema, K. B., & Bista, M. B. (2006). *A study on student performance in SLC*. Kathmandu: Ministry of Education and Sports
- Núñez, R. (2006). Do real numbers really move? : Language, thought, and gesture: The embodied cognitive foundations of mathematics In R. Hersh (Ed.), *18 unconventional essays on the nature of mathematics* (pp.160-181). New York: Springer.
- Pickles, P. A. C. (2004). *Inclusive teaching, inclusive learning: Managing the curriculum for children with severe motor difficulties*. London: David Fulton.
- Radhakrishnan, S. (1927). *Indian philosophy* (Vol. II). London: George Allen & Unwin Ltd.
- Redfield, R., Linton, R., & Herskovits, M. J. (1936). Memorandum for the study of acculturation. *American Anthropologist* (38), 149- 152.
- Restivo, S. (1994). The social life of mathematics. In P. Ernest (Ed.), *Mathematics, education, and philosophy: An international perspective* (pp. 209-220). London: Falmer Press.

- Restivo, S., & Bauchspies, W. (2006). The will to mathematics: Minds, morals, and numbers. *Foundations of Science*, 11(1), 197-215.
- Richardson, L., & St Pierre, E. (2005). Writing: a method of inquiry. In N. Denzin & Y. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 959-578). Thousand Oaks: Sage.
- Roth, W. -M. (2005). Auto/biography and auto/ethnography: Finding the generalized other in the self. (In Roth, W. -M. (Ed.), *Auto/biography and auto/ethnography: Praxis of research method* (pp. 3-21). Rotterdam: Sense Publishers.)
- Rowlands, S., & Carson, R. (2002). Where would formal, academic mathematics stand in a curriculum informed by ethnomathematics? A critical review of ethnomathematics. *Educational Studies in Mathematics*, 50(1), 79-102.
- Rowlands, S., & Carson, R. (2004). Our response to Adam, Alanguì and Barton's "A Comment on Rowlands & Carson 'Where would Formal, Academic Mathematics stand in a Curriculum informed by Ethnomathematics? A Critical Review'". *Educational Studies in Mathematics*, 56(2), 329-342.
- Schech, S., & Haggis, J. (2000). *Culture and development: A critical introduction*. Oxford: Blackwell Publishers.
- Sharma, G. (1986). *History of education in Nepal (in Nepali)*. Kathmandu: Makalu Publication.
- Skovsmose, O. (2005). *Travelling through education: Uncertainty, mathematics, responsibilities*. Rotterdam: Sense.
- Skovsmose, O., & Valero, P. (2001). Breaking political neutrality: The critical engagement of mathematics education with democracy. In B. Atweh, H. Forgasz & B. Nebres (Eds.), *Sociocultural research on mathematics education: An international perspective* (pp. 37-55). Mahwah N.J.: Lawrence Erlbaum Associates.
- Sri Aurobindo. (1952). *Integral education*. Pondicherry: Sri Aurobindo International University Centre.
- Sternberg, R. J. (2007). Who are the bright children? The cultural context of being and acting intelligent. *Educational Researcher*, 36(3), 148-155.
- Taylor, P. (1996). Mythmaking and Mythbreaking in the Mathematics Classroom. *Educational Studies in Mathematics*, 31(1/2), 151-173.
- Taylor, P., & Campbell-Williams, M. (1993). Discourse toward balanced rationality in the high school mathematics classroom: Ideas from Habermas's critical theory. In J. A. Malone & P. C. S. Taylor (Eds.), *Constructivist interpretations of teaching and learning mathematics* (pp. 135-148). Perth, Australia: Curtin University of Technology.
- Taylor, P. C., & Cobern, W. W. (1998). Towards a critical science education. In W. W. Cobern (ed.), *Socio-cultural perspectives on science education: An international dialogue* (pp. 203-207). Dordrecht, Netherlands: Kluwer Academic Publishers.
- Taylor, P. C., & Wallace, J. (Eds.). (2007). *Contemporary qualitative research: Exemplars for science and mathematics educators*. Dordrecht, The Netherlands: Springer.
- Taylor, P. C., Luitel, B. C., Tobin, K. G., & Desautels, J. (in press). Forum: Contextualism and/or decontextualism, painting rich cultural pictures, and ethics of co-authorship. *Cultural Studies of Science Education*, 2(3).
- Van Maanen, J. (1988). *Tales of the field: On writing ethnography*. Chicago: University of Chicago Press.

- Vithal, R., & Skovsmose, O. (1997). The end of innocence: A critique of 'Ethnomathematics'. *Educational Studies in Mathematics*, 34(2), 131-157.
- Wilber, K. (1996). *A brief history of everything* (1st ed.). Boston: Shambhala.
- Wilber, K. (2004). *The simple feeling of being: Visionary, spiritual and poetic writings*. Boston, MA: Shambhala.
- Wong, W.-c. (2006). Understanding dialectical thinking from a cultural-historical perspective. *Philosophical Psychology*, 19(2), 239-260.
- Young, I. M. (2000). *Inclusion and democracy*. London: Oxford University Press.