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EMBEDDING AUTHENTICITY AND CULTURAL RELEVANCE IN THE PRIMARY MATHEMATICS CURRICULUM

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Most countries advocate ideals of an authentic and culturally relevant mathematics curriculum. These ideals, however, are either lost in translation from the intended to the enacted curriculum or are subsumed by the challenging dilemmas of whose 'cultural relevance' needs to be addressed and how. We describe recent innovative initiatives in India and Australia to indicate how these ideals are operationalised in the intended curriculum within very diverse contexts. In India, culturally relevant thematic units were designed as part of the national primary mathematics textbooks drawing upon the knowledge and living contexts of people from the world of work, vocations, and crafts. In Australia, authentic inquiry-based units in a predominantly urban context engaged students in complex problems within their lived experiences. Although in dramatically different contexts, this paper delineates common opportunities and challenges in both that are worth exploring.
National curriculum; cultural relevance; mathematical inquiry; social justice

INTRODUCTION

The shift towards more authentic uses of mathematics in primary school classrooms has momentum that crosses national boundaries (e.g., NCERT, 1993, 2005; MCEETYA, 2006; OECD, 2009). The argument has been that a focus on mathematical concepts and skills devoid of application has lead to a number of challenges: difficulty in transferring mathematical concepts to authentic problems (Nunes, Schliemann, & Carraher, 1993; Saxe, 1988), students seeing little relevance in mathematics (McPhan, Morony, Pegg, Cooksey, & Lynch, 2008; Rampal, 2010) and a sharp decline in students studying mathematics (Australian Academy of Science, 2006; National Research Council, 2007). The urgency is compounded by a growing need for democratic and universal participation in school, better numeracy among citizens and increased mathematical expertise in the workforce.

Curricular decisions indicate the broad aims of education, and especially in the case of mathematics, shape the way school knowledge influences learners' participation through either enhancing or thwarting their motivations and self image. Critical theorists have analysed the relationship between 'official knowledge' and power in curricula, and the role of texts in shaping social realities, hegemonies and conflicts. According to Apple (2000):

> Textbooks … signify, through their content and form, particular constructions of reality, particular ways of selecting and organizing that vast universe of possible knowledge. They embody what Raymond Williams called the selective tradition: someone's selection, someone's vision of legitimate knowledge and culture, one that in the process of enfranchising one group's cultural capital disenfranchises another's. (p. 48)

Moreover, within educational research texts assume importance and merit investigation because they often represent the nodal point of most classroom transactions (Stein, Remillard, & Smith, 2007). This paper will highlight approaches being taken in two diverse contexts—India and Australia—to use innovative curriculum materials. The materials were designed with the specific intent of increasing students' access to learning mathematics in ways that are relevant to their familiar and local contexts and cultures. Specifically, we discuss a recent impetus to include culturally relevant thematic units in Indian primary school textbooks and to use authentic problems to enact the Australian curriculum's rationale of inquiry-based learning. These contexts are unique and clearly distinct, but there are common challenges and opportunities in both situations that we hope to explore.

AUTHENTIC AND CULTURALLY RELEVANT CURRICULUM

Literature has long recommended for curriculum to adopt more authentic problems. By focussing on "authentic", we align with educational aims that empower critical participation through problems that are encountered within everyday experiences and cultures of learners, thus enabling them to mathematise the world from their perspective (Van Oers & Wardekker, 1999). Research suggests that when problems are rooted in the contexts of learners, students can demonstrate mathematical skills that surpass performances on traditional mathematical measures (Hmelo-Silver, Duncan, & Chinn, 2007; Nunes et al, 1993; Saxe, 1988). Social justice recognises that students come with different starting positions due to contrasts in their language, literacy, culture, aspirations, geography, voice, worldview and life experience (Jorgensen & Perso, 2012). This diversity, if not viewed as a 'deficit' to be fixed (Valencia, 1997), brings a wealth of insight to authentic problems.

Curriculum documents tend to advocate ideals of authentic and culturally relevant aims, with the particulars of implementation absent. "[Curriculum] theory covers and formulates the *regularities* among the things and events it subsumes.… It leaves behind the non-uniformities, the particularities" (Schwab, 1978, p. 309) of local implementation.. For example, often when "authentic" curriculum aims are translated into practice, problems may *appear* contextual, but tend to polish out the messiness of reality.. Lubienski (2000) cautioned that these "pseudo-contextual" problems disadvantage some students. In particular, they add a layer of challenge for students who fail to tease out tacit assumptions inherent in "school" mathematics problem which differ from those they encountered in life.

Another challenge this paper addresses is to view "authentic" problems without the hidden assumption that students are a monocultural and monolocational group, with monoexperiences in their repertoire, acknowledging that "greater equity is achieved through providing different learning experiences that try to bridge the differences in starting points". (Jorgensen and Perso, 2012, p. 118). Moreover, it underscores that mathematics "to read the world" needs what Freire (1970/1998, p. 62) called "problem posing pedagogies", as distinct from problem solving ones, so that education "involves a constant unveiling of reality ... that strives for *critical intervention* in reality". It thus reiterates Gutstein (2006) in distinguishing between using mathematics in real world settings, usually about shopping, travelling, working and building, from those that ask students to critically investigate issues of injustice, through a sense of collective social agency.

THE INDIAN CONTEXT

Mathematics is often referred to as the 'killer' subject and in India a large number of children fail or drop out before completing elementary school because they cannot cope with the demands of the school curriculum. The Report 'Learning Without Burden' (NCERT, 1993) had pointed out that children were in fact not 'dropping out' but were being 'pushed out', owing to the 'burden of non-comprehension', as a result of an irrelevant curriculum, distanced from the lives of the majority, and often rendered 'boring and uninteresting' by outdated teaching strategies. The National Curriculum Framework (NCF) 2005 (NCERT, 2005) guided the development of new curricula and textbooks based on a social constructivist approach to ensure more inclusive and democratic participation of all children (Rampal, 2010). It recommended blurring of rigid boundaries that encapsulate school disciplines, and called for consciously removing the sharp dichotomies that exist between the knowledge of school and that of the child's home and community. This has led to the development of new textbooks which, at the primary level, attempt to locate mathematics in the diverse socio-cultural contexts of children's lives, and draw upon folk and street mathematics (Rampal, 2003a; 2003b), specially while developing some thematic chapters around people's knowledge from the world of work, vocations, and crafts.

The NCF 2005 also underscores that access to quality math education is the right of every child and that curricula must address significant numbers of those who might exit after elementary school, while preparing them for the challenges they face in life. Subsequently, the Right to Education Act implemented since April 2010, for children aged 6-14 years, mandates "learning through activities, discovery and exploration in a child centred and child friendly manner" by "making the child free of fear, trauma and anxiety" (GoI, 2009; Section 29) and bans competitive Board examinations and screening procedures for admission, with significant implications for mathematics.. The traditional pattern of examinations has been extremely selective, based on contested notions of mathematical 'talent', and has not only intimidated children but has also dissuaded creative teachers, since their efforts to encourage sense making tend to get obliterated by the focus on procedural questions devoid of meaning and contextual relevance.

A decade of curriculum renewal efforts to embed authentic context even in assessment procedures were made in Kerala which, though the only state to have achieved near universal elementary schooling, remained concerned about issues of quality and equity in education. Every examination question termed an 'evaluatory activity' was viewed as a 'learning activity', while children drew upon their experiences to relate problems and computations to actual real life situations.

The Kerala State Scholarship exam conducted after Class VII, for instance, contained the question given in Figure 1 (translated from the original in Malayalam) for the computation of compound interest, framed in the context of how different banks actually advertise loans. A prior 'non-evaluatory' discussion, with time allocated for it, was integral to the activity, and teachers were given directions about the nature of questions to be asked before presenting the problem, in order to place children in the specific context and frame of mind and, importantly, to reduce the usual anxiety of being examined. The aim was also to give space for students to

talk about the contexts within which their families are compelled to take loans and the problems they may have faced, either through the system of money lenders or even banks. This was clearly a departure from the routine practice of handing this out as an unquestioned problem of computation, where context was only to invoke a real life 'setting' with a contrived or limited purpose (Dowling, 1998), without acknowledging the cultural conflicts or other social implications of 'real' lives.

Problem Solving (Compound Interest)

As a non-evaluatory activity the facilitator and the children participate in a ***discussion***
What are the different banks in your place? Have you ever been to a bank? For what? How is a bank useful to us? For what all needs do they give loans? What are the interest rates for these different types of loans?

Presentation*: The facilitator presents the problem in the form of a story.*

Dileep decided to build a house. He did not have enough money with him. He had to collect Rs. 2 lakhs more for this purpose. Just then he came across two advertisements in a newspaper.

Problem

Dileep wanted to take a loan of Rs. 2 lakhs. Which bank will be more beneficial for him? Why? He will be able to repay this loan after 3 years. What will be the total amount he has to pay to the bank then?

1. Dhanasree Bankers *(with illustrations as in an actual bank advertisement)*

Attractive Housing Loans!

Amount	*Interest Rate*
Up to 2 lakhs	*12%*
Above 2 lakhs up to 5 lakhs	*13%*
Above 5 lakhs	*14%*

2. Sreelaxmi Bankers

Grand reduction in interest rates!

- *Interest only Rs. 150/- for Rs. 1000 for a year (up to 2 lakhs)*
- *Interest only Rs. 160/- for Rs, 1000 per year (above 2 lakhs and up to 5 lakhs)*
- *Interest only Rs. 170/- for Rs. 1000 for one year (above 5 lakhs)*

Figure 1. From Kerala State Scholarship exam after Class VII (translated from Malayalam)

National Textbooks: Thematic units

The national textbooks for primary mathematics, titled *Math-Magic* developed as part of the National Curriculum Framework (NCERT, 2005), conceived of units/chapters in two ways. Most focussed on concepts as progressively developed in the syllabus, with a few thematic ones built around contexts that invoke concepts already learnt. For instance, chapters such as 'Building with Bricks', 'The Junk Seller', or 'The Fish Tale' were thematic units that were not directly linked to one mathematical concept but were developed to focus on specific contexts emerging from the lives of craftspersons engaged in masonry, brickwork design and brick making, junk collectors and sellers, and fishworkers, boatsmen or fish sellers. *Building with Bricks* in Class IV begins with the true instance of a school being built by local masons, who are taken to visit the nearby mosque to observe the amazing variety of floor patterns built by their ancestors three hundred years ago. They come back inspired and make their own

brick designs for the school courtyard, With modern bricks different from the older thinner ones, they generate different symmetries and patterns, which students are encouraged to analyse. The unit goes on to measure a brick, to study its faces, see its projections and how (as an example of a cuboid) it can be represented in two dimensions. It prompts students to analyse other brick designs in traditional architecture and uses some examples from the work of Laurie Baker (without naming him), a well known Gandhian architect who devised low-cost environment friendly buildings, before it ends at a kiln where 'hot and fresh' bricks are being made. Besides understanding the process through visuals they also work with contextually large numbers, such as one hundred thousand, by relating it to the number of brick kilns in the country, and to the number of people's lives connected with brick making

The Junk Seller is based on the true story of a young woman Kiran, who had, against all odds, of the poor, highly patriarchal rural society in the state of Bihar, managed to set up her own enterprise in the capital city. In her voice, it narrates her struggle, her early dislike of math in school and her acknowledgement of how it is an integral part of her present vocation that helped change her life and the situation of her family. Through this visual narrative with on-site photographs, the unit deals with her loans, her junk sorting and selling, hiring of collectors, recycling of materials, etc. This unit challenges several prevailing notions of gender and mathematics, the stigma of 'dirty work' as it relates to certain castes and their supposed low position in society, and the traditional notion of 'great leaders as role models', while it inspires young women with a sense of 'social agency' to develop their entrepreneur abilities to transform lives. Interestingly, the focus on cultural relevance and real life contexts caught the public imagination, and leading newspapers and TV channels that followed the development of the new textbooks through 2006-2008 reported on the primary math texts. Full page lead stories, with headings such as "NCERT's Bold New Experiment brings Maths Closer to Life" began with "Ever thought you could study geometry from brick patterns on the walls of a tomb in Murshidabad? Or arithmetic from a junk-seller in Patna? Well that's what the new Class IV math textbook by NCERT is all about: maths and real-life".

THE AUSTRALIAN CONTEXT

School mathematics in Australia too suffers from rote learning and the use of closed problems (Hollingsworth, Lokan, & MacCrae, 2003). Repeated over years, this focus perpetuates a belief that mathematics is a set of fixed rules to be practiced, lacks relevance and is only accessible to a few labelled as mathematically able (McPhan et al, 2008; Schoenfeld, 1988). To counter this belief, mathematical inquiry is recognised for its potential to develop in students deeper understandings, capacities to cope with uncertainty and setbacks and facilities to transfer their mathematics understandings to complex and authentic problems (Goos, 2004; Hmelo-Silver et al, 2007).

Inquiry in mathematics encompasses more than just extended problem solving. It requires establishment of a classroom culture that values student voice, embraces uncertainty, supports student reasoning and decision-making, capitalises on unexpected opportunities for learning, tolerates periods of noise and disorganisation, and encourages public discussion and critique of emerging ideas (Cobb et al, 1991; NRC, 2000). In Australian mathematics

classrooms, however, only 2% of time is spent publicly discussing the mathematical processes and just 8% of time on complex problems (Hollingsworth et al., 2003).

The new Australian Curriculum: Mathematics

In response to sharp declines in students choosing to study mathematics, Australian Academy of Science's (2006) review of disciplinary mathematics called for more authentic applications in teaching and learning mathematics that promote understanding and communicate mathematics as relevant for life. The *National Statements of Learning in Mathematics* (MCEETYA, 2006) set mathematical inquiry as a defining feature in its framework for the future national Australian curriculum.

The new *Australian Curriculum: Mathematics* sought to align the mathematics curricula across its states and territories and to reflect a stronger focus on disciplinary knowledge and proficiencies, general capabilities and cross-curricular priorities (ACARA, 2011). It includes three content strands for Foundation (age 5) through Year 10 (age 15): *Number and Algebra*, *Measurement and Geometry*, and *Statistics and Probability*. Four mathematical proficiencies—*Understanding*, *Fluency*, *Problem Solving* and *Reasoning*—cut across mathematics content at every grade level. Although the mathematical practices which underpin Understanding and Fluency have long been the focus of mainstream mathematics classrooms in Australia, there has been less success developing a culture of Problem Solving and Reasoning in classrooms. Inquiry depends on these last two proficiencies. Unfortunately, the National Curriculum reifies the imbalance towards consuming and rehearsing mainstream knowledge as Understanding and Fluency are articulated in 53% and 56%, respectively, of the content elaborations, while Problem Solving and Reasoning are present in only 12% and 7%, respectively (Atweh, Miller, & Thornton, 2012).

Curriculum units for mathematical inquiry

The framework and rationale of the Australian Curriculum aim to connect mathematics to students' lived experiences, assist them to see the relevance and utility of mathematics for solving everyday problems, see solutions as an iterative process of refinement rather than a set "correct" procedure to follow and encourage students to focus on evidence, reflect on progress and challenges and critique ideas. In anticipation of these ideals, Allmond, Wells and Makar (2010) published curriculum units as resources to assist teachers to embed mathematical inquiry in their classroom. These units engaged students in addressing ill-structured problems, requiring them to continually re-negotiate their understandings of mathematics within a rich context relevant to children's lived experiences. An example unit designed for children aged 6-8 is described below.

Young children use play dough at home and in the early years of schooling to learn through play, build fine motor skills, express imagination and expand their sensory and tactile experiences. One unit of inquiry in Allmond et al (2010) asks the question, *What is the best recipe for play dough?* The unit begins with children exploring and working with play dough to build a common set of experiences, generate enthusiasm and ensure that all children have an opportunity to engage with the context (if some children have not used play dough, for example). The class shares valued characteristics of play dough (e.g., it can be squished, built,

moulded, flattened, etc) to generate descriptive language for talking about play dough qualities. They make batches of play dough using different recipes and through this, meaningfully encounter simple concepts of quantity, fractions and volume. This is an empowering experience for children in which these mathematical concepts are experienced with authentic and desirable results. Through collaborative discussion, they wrestle with devising ways to judge which recipe is best. Children generate ideas in small groups, which they then collectively share and critique with peers. With support from the teacher, they generate criteria for judging the product of each recipe. For example, using a simple scale (☺ 😐 ☹) to judge characteristics of texture (e.g., stickiness, firmness, lumpiness) as well as measure the amount created from each batch, children judge each recipe in small groups and come to consensus about which recipe is the best, defending their decision with the data collected. The ambiguity of the inquiry question ("best") opens up multiple possible outcomes, shifts the focus from a "correct" answer to one that relies on justification, democratic debate and obtaining quality evidence.

Further examples of inquiry units are given in Table 1. Research suggests that children who learn mathematics with inquiry for a year or more have significantly higher levels of engagement (Wells, 2008).

Table 1: Other examples of authentic mathematical inquiry units (Allmond et al, 2010)

Inquiry Question	Topics	Overview
How do we know if we're getting better at hopping on one foot? (ages 6-8)	Invented measures, data analysis, algebraic reasoning (representation, mathematics of change)	Children generate ideas of how to show evidence of improvement. They predict and record data on their hopping (or catching or skipping) as they practice over time. They use their data to describe their own improvement, then collate the data to reach consensus and justify class improvement.
How many television advertisements will a typical Year 4 student watch in a year? (ages 8-10)	Statistical investigation, informal inference, duration	Children design a statistical investigation (plan, collect, organise, represent, interpret, infer from data). Using data they collect on the commercials they watch on TV at home, they negotiate a conclusion to the inquiry question, then compare their findings to national data on children their age.
What is the best Walking School Bus route in our school catchment area? (ages 10-13)	Decimals, fractions, map conventions, scale, unit conversion, duration	Children use Google Maps to devise a route to school for a "Walking School Bus" (group of children walking to school together from multiple starting points with an adult) with a timetable for pickup points along the way.

DISCUSSION AND CONCLUSION

Traditional curriculum practices largely reflect urban middle-class values and abstractions that blur and distort the history from which their knowledge emerged (Howard, 2003). In this paper, we discussed two very diverse settings in which we worked towards operationalising authentic and culturally relevant curriculum. Both instances portray a curriculum based on the knowledge constructed by children in their classroom (Van Oers & Wardekker, 1999), engaging in cultural artefacts and authentic problems that emerge from their local contexts. However, implementation differed between the two countries. In India, the national primary math textbooks were meant to help States develop their own on similar lines, which has not necessarily happened, for either states have just translated and adapted these or have continued using the formal decontextualised approach in their State books. The strong focus on the rich mathematics that lies within children's cultural experience, especially those from socially marginalised backgrounds, has been acknowledged by academics, even by the media, and while children have been seen to find these math books more accessible and interesting, this is yet to be fully appreciated by the system, its teachers and teacher educators, to be incorporated into regular classroom practice, and as part of teacher professional development. Valuing culture was less of a focus in the Australian context, with equity and social justice less apparent. The inquiry-based problems have tended to transcend and quite possibly ignore students' cultural diversity. This is a recognised problem in Australia where indigenous knowledge and ways of knowing are not widely known or valued. Australia is a multicultural country, yet mainstream worldviews are prominently and explicitly colonial, so that success is often measured by the ability to become fluent in the dominant culture, its beliefs, behaviours and ideals (Howard, 2003).

Future work in India requires national agencies and resource persons to work closely with State curriculum developers within the context of each state to review their curricula and develop local textbooks that incorporate authenticity and cultural relevance. Orientation of elementary school teachers and consonant examination reform are also major challenges before the system. In Australia, discussions are underway with one of the state departments of education to embed inquiry lessons into the state implementation of the Australian Curriculum. As inquiry-based curriculum units become more accepted in the Australian context, there are serious issues to consider. For example, as inquiry gains momentum, it seems to have lost some of its texture and richness in providing authentic learning experiences for children. Changes to curriculum do not occur in isolation and there is little benefit from having an inquiry-based curriculum without parallel shifts in the pedagogies and assessments that accompany them. This requires a united effort as in India, with national agencies, resource personnel, curriculum leaders, accountability measures and professional development all working together towards a common goal.

References

Allmond, S., Wells, J., & Makar, K. (2010). *Thinking through mathematics: Engaging students in inquiry-based learning* (Books 1-3). Melbourne: Educational Services Australia.

Apple, M. (2000) *Official knowledge: Democratic education in a conservative age*. London: Routledge.

Atweh, B., Miller, D., & Thornton, S. (2012). The Australian curriculum: Mathematics – World class or déjà vu? In B. Atweh, M. Goos, R. Jorgensen & D. Diemon (Eds.), *Engaging the Australian National Curriculum: Mathematics – Perspectives from the field* (pp. 1-18). Online book: Mathematics Education Research Group of Australasia.

Australian Academy of Science (2006). *Mathematics and statistics: Critical skills for Australia's future*. Melbourne: University of Melbourne.

Australian Curriculum, Assessment and Reporting Authority (ACARA) (2011). *The Australian Curriculum: Mathematics*. Sydney: Author.

Cobb, P., Wood, T., Yackel, E., Nicholls, J., Wheatley, G., Trigatti, B., & Perlwitz, M. (1991). Assessment of a problem-centered second-grade mathematics project. *Journal for Research in Mathematics Education, 22*(1), 3-29.

Dowling, P. (1998). *The sociology of mathematics education: Mathematical myths/pedagogic texts*. New York: Routledge.

Freire, P. (1970/1998). *Pedagogy of the oppressed*. New York: Continuum

Goos, M. (2004). Learning mathematics in a classroom community of inquiry. *Journal for Research in Mathematics Education, 35*(4), 258-291.

Government of India (2009) *The Right of Children to Free and Compulsory Education Act, 2009*. New Delhi: Ministry of Law and Justice, Government of India

Gutstein, E. (2006). *Reading and writing the world with mathematics*. New York: Routledge.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99-107.

Hollingsworth, H., Lokan, J., & McCrae, B. (2003). *Teaching mathematics in Australia: Results from the TIMSS 1999 Video Study*. Camberwell, VIC: Australian Council for Educational Research.

Howard, T. (2003). Culturally relevant pedagogy: Ingredients for critical teacher reflection. *Theory into Practice, 42*(3), 195-202.

Jorgensen, R., & Perso, T. (2012). Equity and the Australian Curriculum: Mathematics. In B. Atweh, M. Goos, R. Jorgensen & D. Siemon (Eds.), *Engaging the Australian National Curriculum: Mathematics – Perspectives from the field* (pp. 115-133). Online book: Mathematics Education Research Group of Australasia.

Lubienski, S. (2000). Problem solving as a means toward mathematics for all: An exploratory look through a class lens. *Journal for Research in Mathematics Education, 31*(4), 454-482.

McPhan, G., Morony, W., Pegg, J., Cooksey, R., & Lynch, T. (2008). *Maths? Why not?* Canberra: Department of Education, Employment and Workplace Relations.

Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) (2006). *Statements of learning for mathematics*. Melbourne: Curriculum Corporation.

National Council for Educational Research and Training (NCERT) (1993) *Learning without burden*. New Delhi: NCERT

National Council for Educational Research and Training (NCERT) (2005). *The National Curriculum Framework*. New Delhi: NCERT.

National Research Council. (2000). I*nquiry and the National Science Education Standards: A guide for teaching and learning.* Washington, D.C.: National Academy Press.

National Research Council (2007). *Rising above the gathering storm: Energising and employing America for a brighter future.* Washington, D.C.: National Academy Press.

Nunes, T., Schliemann, A., & Carraher, D. (1993). *Street mathematics and school mathematics*. Cambridge, UK: Cambridge University Press.

OECD (2009). *PISA 2009 Assessment framework: Key competencies in reading, mathematics and science*. Paris: OECD.

Rampal, A. (2003a). Counting on everyday mathematics. In T.S. Saraswathi (Ed.), *Cross-cultural perspectives in human development: Theory, research and practice*. New Delhi, Sage Publications .

Rampal, A. (2003b). The meaning of numbers: Understanding street and folk mathematics. In B. Kothari, P.G.V. Sherry Chand & M. Norton (Eds.), *Reading beyond the alphabet: Innovations in lifelong literacy*. New Delhi: Sage Publications.

Rampal, A. (2010). Curriculum, economic and cultural development. In B. McGaw, E. Baker & P. Peterson (Eds.), *The international encyclopaedia of education* (3rd Ed.) (pp. 307-311). Oxford: Elsevier. doi:10.1016/B978-0-08-044894-7.00057-9

Reitman, W. (1965). *Cognition and thought: An information-processing approach*. New York: Wiley.

Saxe, G. (1988). Mathematics of child street vendors. *Child Development, 59*, 1415-1425.

Schoenfeld, A. (1988). When good teaching leads to bad results: The disasters of 'well-taught' mathematics courses. *Educational Psychologist, 23*(2), 145-166.

Schwab, J. J. (1978). *Science, curriculum, and liberal education*. Chicago: University of Chicago Press

Stein, M., Remillard, J., & Smith (2007). How curriculum influences student learning. In F. Lester (Ed.), *Second handbook for research in mathematics teaching and learning*. Reston, VA: NCTM.

Stigler, J., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York: Free Press.

Valencia, R. (Ed.) (1997). *The evolution of deficit thinking: Educational thought and practice*. London: Falmer Press.

Van Oers, B., & Wardekker, W. (1999). On becoming an authentic learner: Semiotic activity in the early grades. *Journal of Curriculum Studies, 31*(2), 229-249.

Wells, J. (2008). *Affective, behavioural and cognitive engagement in primary school mathematics: The impact of inquiry-based learning*. Unpublished masters thesis, School of Education, The University of Queensland.